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ROYAL METEOROLOGICAL SOCIETY.

EDITED BY

A COMMITTEE OF THE COUNCIL.

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Royal Meteorological Society.

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SESSION 1885.

DATES OF MEETINGS.

January*	21	May	20
February	18	June	17
March	18	November	18
April	15	December	16

* Annual General Meeting.

The Chair will be taken at 7 p.m.

By permission of the Council of the Institution of Civil Engineers, the above Meetings will be held at 25 Great George Street, Westminster, S.W.

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ERRATA.

Page 64, line 5 from bottom, *for* "Langor Island" *read* "Saugor Island."

Page 140, line 1, *for* "institution" *read* "institutions;"

" " *after* "Greenwich" *insert* "and the Royal Agricultural College, Cirencester."

Page 186, line 3 from bottom, 2nd column, *for* "2" *read* "1."

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VOL. XI. JANUARY 1885. No. 53.

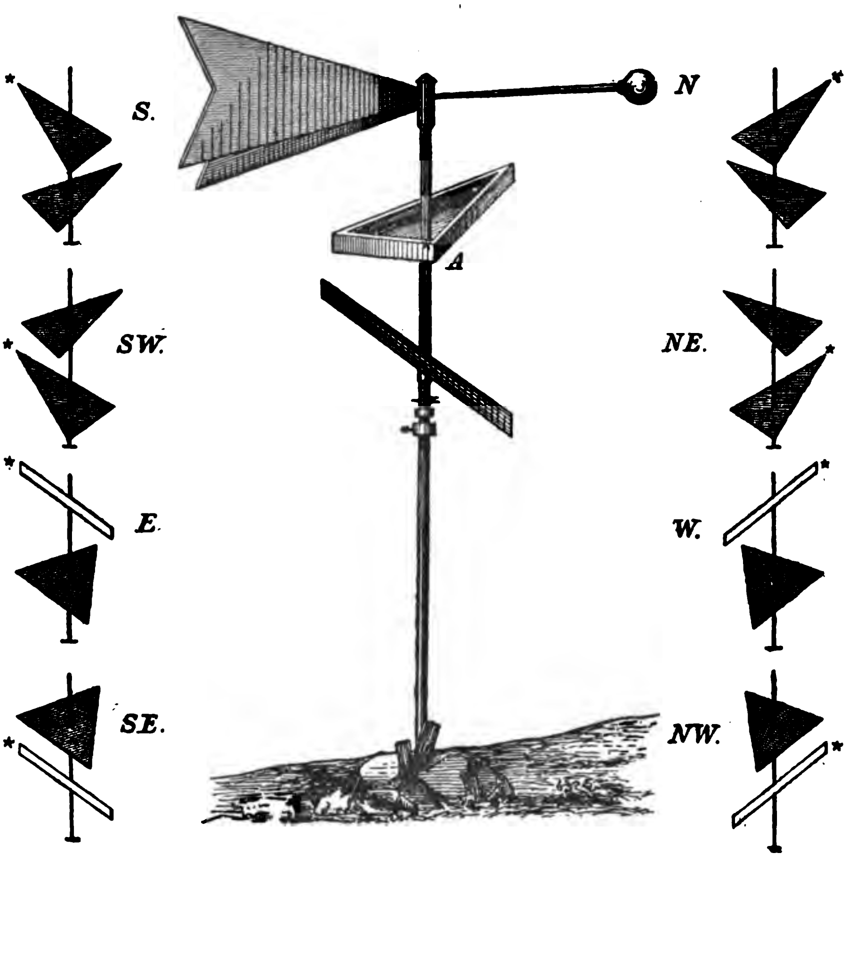
A New Method of Reading the Direction of the Wind on Exposed Heights, and from a Distance. By Hugo Leupold, F.R.Met.Soc., Assoc.M.Inst.C.E. Plate I.

[Read November 19th, 1884.]

The instruments about to be described have been specially designed for hilly and mountainous districts, where local vanes are often unreliable, owing to their being influenced by valley draughts, &c. Being interested in meteorological observations, and living mostly among the mountains, I have often found great difficulty in obtaining the true direction of the wind by the usual method of observing a local vane, the smoke, or clouds, as the first two are invariably affected by valley draughts, &c. while the latter are often not visible. A vane on an exposed height therefore naturally suggests itself; but this again offers certain difficulties, as such a position is not always close at hand, and if at some considerable distance, the reading of the ordinary vane is almost impossible, by reason of its foreshortened aspect, when partially pointing towards, or from, the observer. As the instruments I am about to describe surmount these difficulties, and as doubtless others as well as myself, have felt the want of such instruments a short account of them may perhaps not be unacceptable.

The instrument, shown in the fig. (p. 2) is an ordinary vane, standing about 8 feet above the ground; the vane proper (4 feet long) has depending

from it a tube or sleeve, which partially covers the supporting column, but does not touch it, so as to have free movement around it. On this sleeve, which moves with the vane, two open triangles are fixed at such angles and positions that the same when turned show different shapes to the point of observation. By looking at the code of signals at each side of the engraving, it will be readily seen how these figures are formed. As an example, we shall suppose the direction of the wind is North. In looking up to the vane we first note which of the two triangles has its lowest corner in a line with the pole (as at A in the illustration); it is the top one. We again note: is the highest corner right or left of the centre? It is to the right. With this information we turn to the code, and find: top triangle with highest corner right indicates North. Had the highest corner been left, South would have been our answer. This rule is equally applicable to the lower triangle. Then again, had we in the first observation seen a slanting line (the thickness of the triangle) we should have noted if its highest extremity was right or left of the vertical centre line, and this point would at once settle whether the wind blew from East, South-east, West, or North-west. (The last named position is shown by the lower triangle.)



In 1882 a vane of the foregoing description was erected above the village of Pontresina, Switzerland, at a height of nearly 8,000 ft., or 9,000 ft. above the sea; and as Pontresina is a station of the Swiss Meteorological Department, and has its local official vane in the village, an excellent opportunity for comparing the two presented itself. I naturally conclude that the local vane is considered satisfactorily placed by the department, observations being daily taken from it; and as the mountain vane is erected 8,000 ft. higher, in a very exposed position, we may take it that this too ought to give a very correct indication of the wind's direction. With the kind assistance of the Pastor at Pontresina, who makes the observations for the Department, I was able to compare the indications of both vanes for the space of three months (the respective observations always being taken at the same time). I append a tabular statement of the daily results for one month, to show the great difference which sometimes existed, and leave it to the reader to form his own opinion which of the observations are most likely to be correct, taking into consideration the position of the respective vanes, and assuming that both are in good order and properly observed.

To show the desirability of an instrument as above described for hilly and mountainous districts, I would mention the village Poschiavo, situated also in this canton, where the South wind often blows on to the northern side of the village, having had its course completely changed through the influence of the side valleys of that neighbourhood.[1]

OBSERVATIONS OF LOCAL AND MOUNTAIN VANES AT PONTRESINA, FROM JUNE 15TH TO JULY 15TH, 1884.

June.	Local Vane.	Mountain Vane.	July.	Local Vane.	Mountain Vane.
15	SE	NE	1	SE	SW
16	SE	NE	2	SE	N
17	SE	E	3	SW	SW
18	SE	N	4	SE	SE
19	SE	NE	5	SW	E
20	SE	N	6	SW	SW
21	SE	NE	7	SW	N
22	SW	SW	8	SE	NE
23	SE	NE	9	SE	SW
24	NW	NE	10	SE	N
25	SE	E	11	SE	NE
26	SW	NE	12	SE	SW
27	SE	NE	13	W	SW
28	SE	NE	14	SE	NW
29	W	N	15	SE	NW
30	SE	NE			

[1] Since the above paper was written, a vane similar to that described in the first part of this account, has been supplied to the well-known climatic health resort Davos in Switzerland, and erected on the "Bremenbühl," 2,278 feet above the village, or 7,888 feet above the sea.

I have attached to this particular instrument a wind gauge, which can also be read from a distance, and is of the following construction:—A pressure plate hangs from the index of the vane so as always to face the wind. It swings freely on two centres, and

With the same object in view as that of the foregoing instrument, and with the additional wish to obtain the velocity and consequently strength of the wind, I constructed an electric anemograph of the following description, which also may recommend itself to the attention of meteorologists, on account of its simplicity and novelty of design. The apparatus consists of automatic sending and receiving instruments. Fig. 1 (Plate 1) represents the sending instrument in part section, and consists of a set of Robinson's cups, mounted on a vertical spindle *a*, which in its turn carries near its lower extremity an arm *b*, to the end of which two springs *cc* are attached. These springs or feelers travel round the disc *d*; this disc is attached to the vane *f* by means of a hollow shaft, and turns with it, consequently taking its position in a horizontal plane from the wind. The vane *f* is of the Beckley pattern, having two small steering fans, *h*, working the worm *g* gearing into the fixed wheel *j*, the latter being cast on the frame of the instrument. Fig. 2 gives an enlarged plan of this disc *d*, which is of some insulating material, such as vulcanite; on this there are fixed eight brass segment plates, four on the top as shown at *m*, and four underneath. These plates have each a lug projecting upwards at right angles, which lugs are arranged concentrically round the collar of the insulating disc, as at *k* (fig. 1), those of the lower plates projecting through from underneath, as shown at k^1, k^3, k^5, and k^7 (fig. 2). Now when the disc turns to the right or left, these lugs are brought underneath and into electric connection with the spring *l*, one lug never leaving the spring till the other touches it. This is the position in fig. 2.

The springs or feelers *cc* (fig. 1), which are continually travelling round the disc *d* through the agency of the cups and spindle *a*, are in connection with one pole of the battery, the spring *l* being attached to the other, and it follows that the electric current passing from the spring *l* to any one of the lugs which may be under it, and consequently to the segment belonging to that lug, will complete its circuit as soon as the springs or feelers *cc* touch the edge of this particular segment; and if now an ordinary Morse printer is included in this circuit, it will continue to print a line so long as this connection is main-

actuates by means of side levers and connecting rods a horizontal sliding ring, which latter works up and down on guides placed above the vane, and in continuation of the vertical axis of the whole instrument. It follows that when the pressure plate is lifted by the strength of the wind from its normal hanging position to the horizontal, the ring will rise from the lower extremity to the top of its path, the amount of rise being naturally regulated by the pressure on the plate. The path of this ring is divided by five smaller horizontal rings, fixed at such distances from each other as to represent, according to the angle of the pressure plate, the wind velocities of 0, 2, 6, 10, 20 metres per second. An observer in the valley need therefore only note near, or over, which smaller ring the larger one stands, to obtain at a glance the approximate velocity or pressure with which the wind is at that moment travelling. These smaller rings naturally appear from a distance as mere lines of a large measuring scale, and the larger ring being thicker and longer, is easily recognised as representing the index. All the working parts of this gauge are counterbalanced, excepting the plate, which is acted on by the wind.

tained, and provided the edge of the segment has an unbroken surface; but as each plate carries a certain number of notches to represent dots and dashes, as in the Morse alphabet, we do not get a plain line, but a special set of marks for each plate (*See* code, fig. 3).

The action of the instrument will be more readily understood by the following example: suppose the wind is from the West-north-west, the vane with the disc *d* would turn in that direction, and would bring the lug k^1 which belongs to the segment North-west, and k^2 which belongs to the segment West, under the spring,[1] as in the plan (fig. 2). The two springs or feelers *cc*, which are continually making their round, will naturally make contact directly they touch these segments, and would by passing over the notches on their outer edge send the dots and dashes to the receiving instrument, as per code, the two sets of signals meaning that the wind is between those points. Again, had the wind been in the West, only k^2 would have been below the spring, and therefore only one set of signals would have been transmitted, namely those opposite West in the code. It must be remembered that the segment for North-west is not seen in the plan fig. 2, being under that for North. (*P* is the reducing gear for springs *cc*.) So far, then, I have endeavoured to explain the mode of obtaining the direction of the wind; as for the velocity, we need only time the space between two consecutive direction signals, for as the cups travel in proportion to the wind, the signals forwarded by them will be more or less frequent in a given time, and in a certain ratio to the wind's velocity.

By referring to fig. 1, we see near the lower end of the spindle a small worm wheel with a pin projecting from its face; this pin *o* strikes the spring *n* once in every revolution, and the wheel turns once to forty turns of the spindle and cups; so that by passing the current through this pin *o* and spring *n*, we only get one observation at every forty turns of the cups in our receiving instrument, and thereby avoid too frequent messages.

To take another example, we will suppose the wind is travelling at 5 miles per hour, and as one mile per hour means about 8 revolutions of the cups per minute, after allowing for slip, &c. and as our reducing gear is 40 to 1, we should have one minute between the signals for a velocity of 5 miles per hour; but had the time been only 30 seconds, the velocity would have naturally been 10 miles an hour, and so on.

The receiving instrument consists of the ordinary "Morse" printing telegraph, with the paper ribbon travelling at a uniform rate of fifteen inches per minute; on the side of the instrument and conveniently placed for the observer there is a small dial, the index of which is in connection with the driving roller of the ribbon, and shows at a glance the length of paper that passes through the instrument; but instead of giving the same in inches, &c. the

[1] On the ground of simplicity it was considered sufficient for the so-called false points to be represented by signals on each side of the same, and not to have a special segment. Thus, for West-north-west the sign would be the cardinal point West, and half cardinal, North-west.

dial is marked from one to eighty miles, for, as already mentioned, the length of paper between two consecutive signals is in direct proportion to the velocity of the wind.

We need now then only place the index of this dial at zero, and start the clockwork at the first sign of a message, and whilst this is being printed off watch the index and note its position directly the second message commences; we can then read off the velocity in miles per hour, and also the direction by the signs on the tape. To once more take an example, we will imagine the wind in the North, with a velocity of ten miles an hour. We start our "printer" at the first click of the magnet, and let the papers run on. As soon as we get the commencement of the next message we look at the dial, and find it shows ten miles, as only 7½ inches of tape have run through the roller; this represents half a minute. Had the whole 15 inches of paper passed through, it would have represented one minute, and brought the index to five miles an hour.

It will be evident that the ordinary registering cylinder or chronograph can also be employed for continually recording the observations, if preferred.

In conclusion, I would again draw attention to the simplicity of the apparatus compared to other electric anemographs, and also to the fact that as the springs or feelers *cc* can be regulated to the greatest nicety, the friction is just as uniform as in the ordinary train of wheels. We have here therefore instruments which are just as applicable to the house as to the hills and mountains, the wire connections between the transmitter and receiver saving a great deal of cutting away of woodwork and of making holes.

It need hardly be mentioned that the apparatus can be modified in various ways to suit special circumstances.

DISCUSSION.

Mr. Lecky said that Mr. Eaton had informed him that the wind at Pontresina was nearly always North-east or South-west, owing to the position of the valley. Regarding Mr. Leupold's anemograph, he considered it was beautifully simple, as the one wire was made to record both the direction and the velocity of the wind, and one battery did all the work. With respect to Mr. Pearson's instrument (p. 62) he was afraid that it would be of very little use, as the many complications would involve a great amount of friction.

Prof. Archibald thought the idea of establishing anemometers on heights a very essential one, as both the velocity and direction of the wind frequently alter considerably with the height above the ground. He had especially noticed this in his kite-flying experiments, being obliged to turn the winding machine round through a considerable angle when hauling the kite down. He had particularly observed when in India that the exposure and elevation of the anemometers varied considerably at different stations. He thought that the instruments should all be placed at an uniform height above the ground, otherwise their results could not be fairly comparable. In cases where mountains were concerned, differences must occur through the deviation of wind, and a comparison of the winds experienced on sides of a mountain with those felt in the valleys could hardly be expected to give good results. With respect to the electric anemograph, he believed that Mr. A. E. Murray at Hastings had had one somewhat similar, although, perhaps, not so perfect an arrangement as Mr. Leupold's. He himself had been at Mount Washington in August this year, and the observers there had

told him that they were carrying on experiments with three anemometers, placed at 20, 40, and 60 ft. above the ground respectively, in order to ascertain what effect increased elevation had on the records of the instruments, and he did not think there could be a better place for making such an inquiry.

Mr. MUNRO supposed the instrument first described was sufficiently near the observer to be read with the aid of a telescope; and if this was the case, a pair of mitre wheels and skeleton dial might be added to the instrument, and the dial read off directly, by that means the code of signals would be dispensed with.

Mr. BAILY remarked that in the integrating anemometer he had invented, the North and South, and the East and West wheels were both on one disc. He thought that Mr. Pearson's instrument might be much simplified.

Mr. WHIPPLE said that Mr. Leupold's anemometer was a very pretty notion, but he was afraid that it would not become popular, at any rate in this country. The code seemed to him an objection, but that might perhaps be made even simpler than it was. The vane certainly was an improvement, as it was very difficult to see the direction of an ordinary vane at a distance. He believed that he had once seen an instrument somewhat resembling Mr. Leupold's anemograph, but could not remember where. Electrical recording anemometers were by no means satisfactory instruments in practice, whatever they might be in theory, as there was a great difficulty in keeping the contacts good, and the batteries frequently ran down during calms.

ON THE INJURY BY LIGHTNING TO THE MONUMENT TO THE FIRST DUKE OF SUTHERLAND, AT LILLESHALL, SHROPSHIRE, APRIL 28TH, 1884. By CHARLES CLEMENT WALKER, F.R.A.S. Plates II. and III.

[Read November 19th, 1884.]

THE Monument to the first Duke of Sutherland was erected by the tenants on the Duke's Shropshire estate on an isolated hill near the pretty village of Lilleshall, between Newport and Wellington. It stands about 200 feet above the surrounding country, the upper platform of the monument being 447 feet above the mean sea level; and the top of the obelisk seventy feet from the platform. The hill has been elevated by the protrusion of basalt which appears on the south-east side, and the rocks on its flanks are the Caradoc Sandstone and the altered Caradoc of the same formation, and apparently of the same age as the Shropshire Wrekin. Except where rocks protrude, the whole surface of the hill is covered with soil from 3 to 8 ins. in depth, and clothed with grass.

For so moderate an elevation the views are very beautiful, the Wrekin being eight miles off, and presenting the best view of its remarkable shape. The Welsh mountains of Denbighshire and Merionethshire, fifty miles distant, show grandly to the left, while on the right are seen Cannock Chase and North Staffordshire. On an eminence, the Duke of Sutherland's residence, Lilleshall House, stands out well, and not far distant are the interesting ruins of Lilleshall Abbey. These backed up with woods, the remains of forests that once covered the land, and a well-cultivated country in the front, make the hill a very favourite resort from all parts.

The obelisk is of sandstone, and was erected in 1833. Six years after its erection, in 1839, it was struck by lightning and so severely damaged that it

had to be taken down and rebuilt. On being rebuilt it appears that the builder fixed on the top, as the apex of the cone, a pyramid of glass about eight ins. square at the base, and also inserted pieces of plate-glass, six ins. wide and thirty ins. in length, in grooves cut in the sides of the cone. As far as we know there is no person living who had to do with the designing its rebuilding, and this use of glass is supposed to have been due to the erroneous notion that its being a non-conductor would prevent the lightning from striking the obelisk.

In the obelisk all the outer stones of the platform are large solid pieces; but the lowermost tier is a facing about six ins. thick, the inner part being filled with rubble, and the upper faces of the platform are flagstones of four or five ins. thick. The obelisk itself also is built on its outer parts of substantial stones, and the inner core being also filled up with rubble; the top stones forming the apex are solid stones, capped as stated with glass.

On April 28th, 1884, about 2 p.m., rain fell, with a high wind which increased by 2.30 to a severe storm with vivid lightning and severe claps of thunder, which followed so soon after the flashes that it was evident the thunder clouds were very near. The author at about 2.45 was driving within less than half a mile of the obelisk during the storm, when one of the most severe flashes he ever saw, followed instantly by tremendous thunder, so frightened his horse that he reared in such a manner that it was with difficulty an accident was prevented.[1] This appears to have been the electric discharge that struck the obelisk. The author was going away from the spot or he would probably have seen it. But it so startled one cottager that he went out to look at the monument, thinking something would have happened, and he states that he saw the stones falling down, a cloud of dust and smoke rising up from the ground all round its base. Another man states he was looking at the obelisk at the time, and saw a cloud near the top, which was covered with lightning, the stones falling, and afterwards a smoke all round it. At a cottage about ninety feet below, and fifty yards distant, a woman was washing in an outhouse, who, on the tremendous shock, thought the cottage was coming down, and naturally remembering her baby, ran into her cottage, was blown with great violence against her door, and so affected by the shock of the explosion that she was ill all the afternoon. She describes her cottage as filled with the smell of sulphur. After the author learned of the accident, he went to the spot and found the monument injured, as is shown in the drawings (Plate 2). The upper part of the obelisk for about ten feet had fallen down, the next nine courses of stone for about fifteen feet were all displaced and pushed out from the centre axis and were in danger of falling, the platform was broken by the falling stones, large stones on the circumference of the platform displaced, and some on the faces of the sides forced out altogether. The sod round the base of the monument was ploughed up in fifteen grooves, three to six inches wide and the same in

[1] Indeed the lightning could hardly be described as "a flash," it was an instant environment of an intense blaze of light.

depth, ten to seventy feet in length, whilst the green grass was scorched brown, evidently by the streams of electricity escaping from the monument. Thinking the results of the stroke worth recording, the author had proper measurements taken and a careful drawing made which is represented in Plate 2.

About half-a-mile distant a quantity of linen and cotton clothes, having been washed and hung out on lines previous to the storm, were afterwards found to be covered with pink coloured spots, which changed to light blue in washing in soft water without soap, and remained after another washing but disappeared in the drying. These can in no way be accounted for but as the result of the storm.

As previously stated, there had been rain for upwards of half-an-hour before the lightning flash; the obelisk, platform and all the ground surrounding were, therefore, moist, yet from the appearance, the lightning did not follow the wet on the outside, for there is no trace of it on the sides of the obelisk, or if it did, this was not sufficient to carry it off, but seems to have gone through the rubble of the centre of the obelisk from top to bottom, and in its endeavour to spread itself in the earth to have forced out the stones of the base as shown (some of which weigh upwards of 25 cwt.), and detaching the side of the lower course altogether on the south-east side, escaped in streams as shown in the diagram (Plate 8.), shattering rock on its way till dissipated. The storm did not cover a great extent of country. It was felt five miles to the south and three miles to the north, but at no great distance east or west of the hill.

It is evident that a serious mistake was made, and a total ignorance of electrical science displayed by those who rebuilt the obelisk in 1889, in their not making provision by a lightning conductor to carry off the discharge of the electric cloud. It was doubtless with the view of not disfiguring the top of the obelisk (for it is a disfigurement to have a conducting wire with its tri-dented forks projecting above the top); yet, judging by the effect, and taking the most favourable conditions for carrying off the lightning if the whole of the obelisk were saturated with wet through the fallen rain, it seems questionable if any conducting wire of the size generally used for the purpose would have been sufficient for carrying off such a discharge as took place in the storm of April 28th, 1884. It will be useful not only to the preservation of the obelisk in the future, but also for other similar structures, to have the opinion of Fellows on this point, and also as to the best mode, with the least disfigurement, to supply such a conductor as may convey away the discharge to the earth, leaving the structure unharmed in any thunderstorm that may arise.

It has been thought desirable to place the whole of the facts before the Society, as doubtless the great experience of many of its Fellows may elicit information which the author does not presume to possess.

DISCUSSION.

Mr. WALKER said that the current H and I forced out and threw to the ground three of the facing stones of the lower course of the base each 2 ft. 9 ins. wide and 6 ins. thick, and the current marked O forced out another, all being thrown

eight or ten feet away, and that the dotted lines B C D E show the probable direction of the current underground, as he put his arm up under the soil, and it was like a rabbit burrow.

Mr. LECKY said that a case of damage by lightning, very similar to that described by Mr. Walker, occurred forty-eight years ago to a church at Blackrock, near Cork. At the time the church was struck there was a heavy hailstorm, accompanied with one flash of lightning. A committee of the Cuvierian Society of Cork was appointed to inspect the church, and to report, but he had been unable to obtain any copy of the report. He was on that committee and saw the amount of damage done, and it certainly appeared that there was as much upward as downward force exerted. The stones were hurled to a considerable distance, and the spire was split from top to bottom but was almost whole except the top. He produced a lithograph of the damaged steeple and spire from an artistic drawing made at the time by Mr. Hill of Cork, and a portion of a stone from the spire sent him by Dr. Caulfield of Queen's College, Cork. He also stated that the church had only been built two years when it was struck, so that the masonry would perhaps hardly have become thoroughly dry.

The PRESIDENT (Mr. SCOTT) remarked that meteorologists generally only spoke of lightning descending in a careless sort of way, because it was connected with the appearance of clouds, which certainly passed over our heads. Every one who thought for a moment must recognise that the discharge was double, upwards and downwards, and that most of the damage done was due to the upward stroke. However, globular lightning did not always go upwards, and he had himself many years ago seen a rare form of electrical discharge, taking place comparatively slowly, in a zigzag path, and forming a star at each angle of the zigzag. This lightning did not ascend.

Mr. CAPRON thought that the diagrams illustrating Mr. Walker's paper certainly seemed to show that the stroke which caused the damage had a downward rather than upward motion, as evidenced by the streamers from the base of the monument.

Mr. WHIPPLE said that he had always understood that describing a lightning stroke as coming downwards was merely the conventional style of speaking, as no definite direction can be assigned to a lightning stroke. So far as the indications of the electrometer were concerned, at Kew the earth was sometimes positive and the air above negative, and *vice versâ*. It did not matter which way the electric current passed through an object, for the effect was due to the explosive decomposition of the material through which it passes—whether it were water converted into its constituent gases by electrolysis, steam at a high pressure, or vaporised metal. Under any circumstances, great force would be generated by the passage of the current.

Mr. DYMOND, referring to the request for advice made by Mr. Walker, said that full instructions for the erection of conductors would be found in the *Report of the Lightning Rod Conference*. He did not think it would be needful to injure the appearance of the obelisk by affixing a crown of points, but believed that a fairly efficient protection would be afforded by the substitution of a copper pyramid for the glass one which had been destroyed, and that a stout copper strap from the cone to the earth down the weather side of the obelisk would be the best and least conspicuous form of conductor. It should be led underground for some distance, and terminate with a thoroughly sufficient earth contact in constantly moist soil.

Mr. MARRIOTT exhibited a photograph of some flashes of lightning that occurred during a thunderstorm at Reichenberg in Bohemia on July 16th, 1883.

Mr. SYMONS remarked that a case of damage to a monument in Scotland is given in Mr. Anderson's book on *Lightning Conductors*, which resembled in several respects the damage described by Mr. Walker. With regard to Mr. Lecky's remark as to the church being a new building, he had noticed that factory chimneys were generally either struck when newly built or when very old; he thought that this might be due to the presence of moisture in the mortar at both periods.

Mr. WALKER said there seemed to be a similarity of character in the fracture of towers, obelisks, spires, &c. when struck by lightning, as in the case of the Duke of Sutherland's monument, for this was evidenced by most of the published illustrations of such occurrences. But he had not been able to find any where such a remarkable distribution of the electric current as here shown. There

were no less than fourteen or fifteen distinct currents all round the base (which was forty feet square), and radial from it, some running seventy feet, and one descending fifty feet, breaking up rock in its passage, as shown on the east side. It is noteworthy that the grooves made in the soil did not thin off in receding from the monument, but continued of the same width and depth until they terminated. He could not think that the damage to the monument was caused by an upward current, as the displacement and pushing outwards of the stones and the marks of the electric streams at the base seemed clearly to show that the stroke was downwards, and the force from the centre outwards. He also drew attention to the peculiar character of the lightning flash which did the damage, it being as stated rather an environment of intense blazing light than a flash. He then quoted an instance of similar lightning which damaged the church at Week-St. Mary in Cornwall, at 6.45 a.m., November 8th, 1878, the account of which is given in the *Report of the Lightning Rod Conference*, p. 30, and is as follows:—"The brightness of the lightning was intense, and I have been at some trouble to inquire into the effect which it had upon those who saw it. I was awake, and the lightning illuminated the room through double chintz curtains and dark-green blinds, the windows looking away from the church, and being more than a quarter of a mile from it; during the storm a farmer took refuge in a closed cattle shed 200 yards from the church, and he spoke afterwards of his impression that he was surrounded by fire; two farmers going to Camelford fair were at the time waiting on the road a mile-and-a-half from the church, and their impression was that they were enveloped in flame, and the flame came between them; these experiences were given to me at different times, and were independent evidences of individual opinion. At Holsworthy, eight miles away, in a direct line, two ladies were attending their sick mother, and the vividness of the lightning obscured the brightness of the light of two candles and a paraffin lamp."

The pink spots on the linen which was drying had not been referred to in the discussion, but the fact that they changed to blue by washing in alkaline soapy water seemed to show that they were acid, and he noticed that Arago, in his *Meteorological Essays*, referred to deposits being left on the walls of houses struck by lightning. He says, p. 275: "The ferruginous spots or stains left on the walls of houses might perhaps be supposed to be derived from the iron which the lightning might have taken up from the portions of that metal always found in buildings; but what can be said of the sulphurous stains on the same walls, and still more, of the ferruginous stains on trees which have been struck by lightning in the open country? M. Fusinieri therefore thinks himself justified in inferring from his experiments that at all elevations, or at least up to the height of storm-clouds, the atmosphere contains iron, sulphur, and other matters of which chemical analysis has not yet determined the character, and that these substances are taken up by the electric spark and brought by it to the surface of the earth, where they form extremely thin and minute deposits around the points which are struck by lightning. Assuredly this new mode of regarding electric phenomena is well deserving of being followed up with all the exactness of which the present state of science is susceptible. All persons, therefore, who may see lightning strike an accessible point, will do a very useful thing by collecting the matter, black or coloured, which the electric fluid appears to have deposited in those parts of its course where abrupt changes of velocity must have taken place. A scrupulous analysis of these deposits may lead to unexpected and highly important discoveries."

ON THE MECHANICAL CHARACTERISTICS OF LIGHTNING STROKES. By COLONEL THE HON. ARTHUR PARNELL, LATE ROYAL ENGINEERS.

[Read November 19th, 1884.]

(I.). LIGHTNING STROKES VIEWED AS EFFORTS OF FORCE.

IN a Report to Government made in 1855 by the late Sir William Snow Harris, there occurs the following remarkable passage :—"What is called lightning is the evidence of *some occult power of nature forcing a path* through substances which offer greater or less resistance to its progress." The theory presented to us by this *dictum* is unmistakeably one that views a lightning stroke as an effort of physical force; and, for my own part, I can unhesitatingly state, the researches I have been able to make in regard to the action of terrestrial electricity during the last five years fully bear out this idea. Having, as I believe, entered into the special study of lightning phenomena with no preconceived physical conceptions contrary to those generally held, the principal impression that these investigations have left on my mind, up to the present time, is that a lightning stroke is a manifestation of ordinary physical force effected in a highly concentrated form. In the present paper it is not my purpose to review the whole subject of the nature and effects of this lightning-force, or "earth-force," as I should prefer to designate it, for its physical scope is certainly of considerable extent; and I doubt if its science—a science that in its broadest sense might conveniently be termed that of *geo-dynamics*—has yet been sufficiently mastered to allow of any exhaustive theory being developed and still less expressed. I propose to submit some notes and facts tending to demonstrate the mechanical nature of lightning strokes, and the direction, in regard to the surface of the earth, that is usually taken by them. As a preface, however, I shall call attention to a short table which I have prepared from an analysis of the whole number of detailed authentic incidents of lightning-stroke action that I have as yet compiled and studied. The number of these incidents is 1,147, and they extend from January 1665 up to February 1884. The object of the table is to make an approximate comparison between the number of instances of *mechanical* work effected by the force of these strokes and the number of instances of *heat* work effected by the same force, and to prove that displays of the former kind of work are more frequent than manifestations of heat. We know that heat is one of the effects of physical force; but we also know that it can be produced by chemical action. But mechanical work is obviously directly effected solely by the immediate action of physical force; and the excess of instances of this work that I have adduced seems to tell in favour of the physical force theory of lightning strokes already mentioned. Out of the 1,147 cases, 224 afford no indication of the exact nature of the work effected by the stroke. Hence the table deals with 923 cases.

TABLE OF THE NATURE OF WORK EFFECTED BY 923 LIGHTNING STROKES ON VARIOUS SUBSTANCES.

	Substances acted on.	Number of instances of	
		Mechanical Work.	Heat Work.
1	Persons and Animals	52	79
2	Clothes, Carpets, Canvas, and Woollen, Linen or Cotton Articles generally	88	79
3	Masonry of all kinds and Rocks	416	2
4	Glass, China, Earthenware, &c.	82	5
5	Metal	206	173
6	Wood	254	98
7	Trees	63	4
8	The Ground	60	..
9	Thatch, Straw, &c.	..	11
10	Gunpowder	..	15
11	Gas	..	19
	Total	1221	485

In the above list the inherent conditions for displaying each kind of work are certainly unequal in respect of the substances numbered 3, 4, 7, 8, 9, 10, and 11; and in connection with No. 1, it should be noted, in regard to the instances given, that the records furnish strong evidence of the difficulty that is always liable to occur in attempting to determine accurately whether the wound which a person may have received is in reality a burn, or only a peculiar incision or mark left by the blow of the stroke; but in regard to Nos. 2, 5, and 6, there is little room for mistake, and it will be seen that in all three of them the mechanical instances overbalance the heat ones. Probably few persons are aware that lightning strokes are more apt to break or bend metal than to fuse it. But it is in wood that the difference is greatest; and this material would appear to be the substance of all others that would soonest display marks of heat. In connection with wood, I was fortunate enough in the summer of 1888 to witness a very complete instance of the action of a powerful lightning stroke on dry timber inside an old house in Lumley, a village in Durham. This incident is No. 898 of the list of cases of upward action given with this paper. The woodwork of the floors and roof of this house was rent and shivered; but a close scrutiny of the whole house could detect no signs of heat work on any substance whatever. And here I may mention that many of the strokes recorded in my collection, and especially of those that displayed exceptional power, exhibit either no trace at all of heat, or merely very slight signs of it.

The main objects of this essay are as follows:—First, to attempt to show that "lightning" is not a sort of electric fluid that descends from the clouds, injures buildings and persons in its course, and dissipates itself in the earth; but that it is a luminous manifestation of the explosion caused by two equal forces springing towards each other simultaneously from the earth and the under surface of the inducing cloud, and coalescing, or dying out

nearly midway between the two plates of the electrical condenser formed by the earth and the cloud. Secondly, to demonstrate that of these two forces it is the earth-sprung or upward force alone which injures buildings, persons, or other objects on the earth's surface, and which constitutes tangibly what is rightly known as a "lightning stroke."

One of the principal facts that arrests the attention of the student of geo-electricity is, the apparent indifference that has been displayed by natural philosophers in regard to the accurate investigation and determination of the direction of the force which is palpably manifested by the great majority of lightning strokes. With the exception of a few dissentients, who in no instance appear to have earnestly upheld their opinions, or to have deemed the matter of more than secondary importance, the physicists of all countries seem, as a rule, to have taken for granted that the popular opinion, holding that lightning streamed (as it were) downwards from the clouds to the earth, was solidly founded, and that any scientific examination as to its truth or error was a sort of research that might justly be placed on a par with an inquiry concerning the philosopher's stone, or the squaring of the circle. The origin of this universally accepted theory of the descending direction of the force of a lightning stroke may, we imagine, safely be attributed to the Greek traditions of Jupiter and his thunderbolts—traditions which perhaps themselves sprang from the Mosaic records of Jehovah raining fire from heaven on the objects of His wrath. Be this as it may, the idea of lightning darting from the cloud, striking buildings, persons or trees in its course, and disappearing in the bosom of the earth, seems to have held sway from the earliest times, and hardly to have been shaken even when, in the middle of the eighteenth century, the new science of electricity shed its light on the nature and action of thunderbolts.[1] It is true that one of the great pioneers of this science, the Italian philosopher Beccaria, who, more than any other man of his time, devoted himself to the study of terrestrial electricity, arrived at the conclusion that the earth was the originator of thunderstorm electricity; but his teaching was not followed by his successor, nor was it accepted by his contemporaries. Among these latter, Franklin certainly at one time reasoned that lightning strokes proceeded in an upward direction; but he does not appear to have proceeded in this line of thought; and (as will be shown hereafter) it is undeniable that the premises on which he based this passing belief were founded on error. When, at the beginning of the nineteenth century, the labours of Galvani and Volta resulted in a knowledge of the evolution of electricity by chemical action,

[1] According to our standard dictionaries the term "thunderbolt" appears to be the correct English expression for a lightning stroke. In this sense it is used in the Scriptures, in the *Phil. Trans. of the Royal Society*, in Shakespeare's Plays, and by Priestley. The word has almost gone out of use, and it is now generally confounded (even by scientific men) with thunderstone, aerolite, or meteorite manifestations, with which it has practically nothing in common. The French, however, seldom use any other term than thunderbolt (*foudre*) to denote a lightning stroke, and they never use the word lightning (*éclair*) for this purpose.

and when the nature of electrical currents began to be comprehended, the natural tendency of the scientific creed of the day was to confirm the generally received theory that lightning was a kind of deadly fluid or current that issued from the clouds and descended with irresistible force on the earth. It is true that all this time the unquestionable uplifting properties manifested by thunderbolts when striking trees, church spires, and many other objects, could not fail to be noticed; but rather than disturb the time-honoured belief in the downward action of lightning strokes, physicists accounted for these upward demonstrations, either by assuming that every stroke possessed what they called an "expansive" force, which they imagined enabled it to hurl great fragments of masonry to a distance of hundreds of yards, and to shiver the trunks of huge oak trees, whilst scattering the splinters in all directions, as if they had been blown up by a mine; or by considering these upward strokes as exceptional phenomena induced by ordinary downward strokes, and by denoting them as return strokes. In the cases of trees the philosophers obtained an ally in the shape of the sap, which they urged was converted by the heat of the stroke into steam, whose vaporous force was supposed to combine with the "expansive" power already mentioned, and thus to afford to the unphilosophical eye all the semblance of a direct upward force.

I now propose to call attention to the discoveries and experiments of various eminent men tending to confirm the particular theory of lightning strokes which I have submitted as being the true one, and also to mention several of the opinions which have been expressed on the subject of the upward direction of these strokes.

(II.). Discoveries and Opinions.

Dufay.—In 1733-37 the French philosopher Dufay made the discovery of two opposite species of electricity, and termed them respectively vitreous and resinous. It was he who first formed the idea of two distinct agencies repulsive with respect to themselves and attractive of one another. This theory appears to have been overshadowed, if not temporarily obliterated, by the "one-fluid" theory described by Franklin in his famous letters written in the years 1747-53. But in 1759 the English philosopher Symmer revived and remodelled Dufay's ideas into the "two fluid" theory that has since been universally accepted as the correct one. It does not appear that Dufay devoted his attention particularly to the physics of lightning strokes; but it seems certain that his ideas on the nature of electricity generally were the germs which alone could originate a true conception of the nature and direction of these strokes.

Maffei.—In 1747 the Marquis Maffei, an Italian philosopher, having, at Castle Fosdinovo, near Carrara, witnessed a stroke wherein it was palpable to him that the lightning had not reached the earth in a descending direction from the clouds, wrote a work entitled *Delle formazione dei Fulmini*, in which, as Arago says (*Essays*, p. 176), "he put forth in a systematic manner his ideas on ascending thunderbolts." What he saw at Fosdinovo immediately before the stroke occurred was a phenomenon which is commonly termed a "fireball." This is a light or flame, perhaps generally of a more or less circular shape (whence its name), that occasionally appears to hover at or near the surface of the ground *just before* a discharge takes place at the spot. Sometimes these luminous appearances are alleged to ascend, sometimes to move horizontally, and sometimes to descend, but the probability is that they hardly last long enough to allow of the mind informing itself exactly of their circumstances. But they appear invariably to

give the spectator the idea that the lightning explosion or thunderbolt bursts from them. There can hardly be much doubt that they are manifestations, under peculiar atmospheric and geographical conditions, of an intense accumulation of electricity at the places where they are seen, such an accumulation, in fact, as electrical law clearly demonstrates must occur on each plate of the terrestrial electrical condenser before lightning explosion happens. The "fireball" is therefore probably a luminous sign of electrical density partaking of nearly the same nature and characteristics as the better known "St. Elmo's fire" which is occasionally visible at night on metallic points during, and previous to, thunderstorms. In the course of this paper several more instances of "fireballs" will be adduced; and I think that strong testimony will be found to be afforded by them in favour of the point which it is the principal object of my essay to establish, viz. the earth-sprung nature and general upward direction of all lightning strokes. Before I proceed further I may perhaps with advantage suggest a caution against confusing these lightning-producing fireballs with any meteoric phenomena to be seen in the heavens; for these latter appearances are frequently spoken of by astronomers and meteorologists as "fireballs" (See Prof. Baden Powell's papers on this subject in the *Reports of the British Association*).

Franklin.—In September 1753, Benjamin Franklin, in No. XII. of the Series of his *Letters from Philadelphia* to Mr. Peter Collinson, F.R.S., describes some experiments he had made in accordance with his electrical theory, already mentioned, for finding whether clouds are usually charged "positively" or "negatively" (terms which he invented to illustrate his theory); and he comes to the conclusion that for the most part "'tis the earth that strikes into the clouds, and not the clouds that strike into the earth" (p. 116). So far as I can ascertain, however, he assumed that the electricity he collected by his apparatus was that of the clouds, whereas it is certain that it was primarily that of the earth. And since he also supposed that "positive" electricity did all the work in an electrical discharge, and that "negative" charge was merely passive or receptive,—suppositions that, even at the present time, and in spite of the general rejection of the theory that originated them, are almost universally entertained,—it is pretty clear that, according to his own showing, his *dictum* should have been reversed. But it is curious to note what little importance he attached to the probability of the generality of strokes being upwards; for he actually states his opinion that the effects and appearances would be nearly the same in either case. In spite of the knowledge possessed by him (in common with all the philosophers of the day) regarding the properties of the electrical condenser, or Leyden jar, and the action of electric sparks, Franklin never seems to have considered whether the earth itself might not possibly be the originator of thunderstorm electricity, nor even to have studied the function of the earth at all in the system of terrestrial condensation of which it clearly formed one or other of the plates.

Beccaria.—We now come to a worthy contemporary of Franklin's—to a man of whom Dr. Joseph Priestley, F.R.S. in his *History of Electricity* (p. 315), says, "All that was done by the French and English electricians with respect to Lightning and Electricity fell far short of what was done by Signor Beccaria at Turin," and again (p. 373), "whose observations and experience with respect to lightning give a weight to his opinion superior to that of any man whatever,"—to the celebrated priest-philosopher Giambattista Beccaria, who wrote from Turin in 1753 and from Bologna in 1758. He says (p. 321): "That the electric matter which forms and animates the thunderclouds issues from places far below the surface of the earth" * * * "is probable from the deep holes that have, in many places, been made by lightning. Flashes have also been seen to arise from subterranean cavities and from wells. The greatest difficulty attending this theory of the origin of thunderstorms relates to the collection and insulation of the electric matter within the body of the earth," * * * "but no person has yet assigned a more probable cause of the redundancy of the electric matter which, in fact, often abounds in the clouds, than what we may suppose possible to take place in the bowels of the earth." Beccaria also conceived earthquakes (p. 360), the aurora (p. 346), and whirlwinds (p. 348), as well as lightning strokes, to be originated by the electricity of the earth; and Priestley (p. 361) says: "It is certain that if Signor Beccaria's account of the origin of thunderclouds be admitted, there will be little difficulty in admitting farther that earthquakes are to be reckoned among the effects of electricity."

Yet with all these decided opinions on the terrestrial origin of thunderbolts, Beccaria never appears to have systematically investigated the direction taken by lightning strokes, nor to have given a clear statement that they were invariably upwards.

Symmer.—The next great name that claims our attention is that of our own countryman Symmer. In connection with Dufay's theory, extensive experiments on electricity were made by Symmer in England, whilst Franklin was pursuing his researches in America. In 1759 Symmer read before the Royal Society papers describing the results of his experiments. These results proved that electrical explosions are always of a double nature, and that they consist of two exactly equal and opposite powers or forces darting simultaneously toward each other from the two plates respectively of the electrical condenser. He says:—"When a quire of paper without any thing between the leaves is pierced with a stroke of electricity, the two different powers keep in the same track and make but one hole in their passage through the paper." * * * * "When any thin metallic substance such as gilt leaf or tinfoil is put between the leaves of the quire and the whole is struck, in that case the counteracting powers deviate from the direct track, and leaving the path which they would in common have taken through the paper, only make their ways in different lines to the metallic body, and strike it in two different points, distant from one another about ¼ inch more or less, the distance appearing to be least when the power is greatest; and whether they pierce it or only make impressions on it, in either case they leave evident marks of motion from two different parts, and in two contrary directions. It is this deviation from a common course, and the separation of the lines of direction consequent upon it, says he, that affords a proof of the exertion of two distinct and counteracting powers" (*Priestley*, p. 256.). It is well known that though Franklin's terms "positive" and "negative" have been retained, Symmer's general theory of the duality of electricity has now every where supplanted Franklin's conception of one fluid, present in excess or in deficiency, which during the latter half of the eighteenth century was the idea generally accepted. But it is extraordinary that the application of Symmer's ideas to lightning strokes should have been tacitly repudiated, and that Franklin's view of a stroke being a discharge issuing solely from what he called the "positive" plate of the condenser should have held its ground. No one, however, could agree with the extracts we have made above without at the same time entertaining the logical result of those extracts, viz. that lightning strokes, as felt by denizens of the earth, must invariably spring *from* the earth, and that in connection with lightning strokes and explosions of condensers generally, the terms "positive" and "negative" are utterly unmeaning and unnecessary. In this connection, Symmer's use of the term "power" in expressing each of the complementary agencies of electricity is very remarkable. From this it is clear that he at all events did not look on an electrical spark (or a stroke of lightning) as a stream or current of ethereal matter. I cannot trace that Symmer ever turned his attention specially to the subject of lightning; and I cannot help thinking that therefore the world has been greatly the loser, for there is every reason for believing that his genius would have thrown much light on the true action of lightning strokes.

Delaval.—In 1764 Mr. E. H. Delaval, F.R.S. gives an account (in the *Philosophical Transactions*) of the destruction of the steeple of St. Bride's Church in London by lightning, and uses these remarkable words:—"The effects were exactly similar to those which would have been produced by gunpowder pent up in the same places and exploded" (*Priest.* 372). He could hardly have described the upward action of the stroke in more vivid language.

Chappe.—In 1767 M. D'Auteroche Chappe published his *Observations sur l'Orage du 6 Août, 1767, et d'un Coup de Foudre qui s'est élevé de la Terrasse de l'Observatoire.* Referring to this philosopher, Arago says:—"Chappe and others deem that lightning or thunderbolts are almost always elaborated on the ground; that it is from the ground they suddenly dart; that instead of descending from the clouds to the earth, their course is on the contrary from the earth to the clouds" (*Essays*, 101).

Mahon.—In 1779 Lord Mahon, F.R.S. published his *Principles of Electricity*, with an explanation of what he called "returning strokes." He assumed as a matter of course that an ordinary stroke descended from the clouds to the earth.

But he convinced himself by experiment that whenever the explosion of a condenser occurred, the electricity induced by either of the plates on other adjacent collectors, not forming portions of the condenser, was also discharged or returned; this "returning stroke" usually occasioning a shock in its passage. In the case of lightning explosions he inferred that the induced strokes attending them might take place at a considerable distance off, and that the direction of their force must be opposite to that of a direct stroke, and consequently upward. Mahon therefore styled these induced discharges "returning strokes"; and when, in 1785, the famous accident at Coldstream took place, on which occasion the manifestations of an upward force were unmistakeable, and two witnesses alleged that no flash of lightning was visible, he read a paper before the Royal Society claiming this case as a confirmation of his theories. Most of the text books of the present day on electricity and meteorology (probably all following the lead of one or two prominent treatises) have in a vague and desultory manner accepted Mahon's ideas that men could be killed by induced shocks; but without (so far as my researches have as yet extended) in any single instance adducing later facts tending to prove the truth of Mahon's assumptions. But even in Mahon's time his theory was contested. In 1794 Mr. G. C. Morgan in his *Lectures on Electricity* says in allusion to this event at Coldstream:—"A storm is lately said to have happened, which killed a man and some horses, without any appearance of light. I have carefully examined the evidences of this story, and I feel no disposition to regard it with the least credulity. That two common men, a Scotch shepherd and a Scotch carter, who acknowledge themselves to have been stunned at the time by the noise, and who were evidently frightened before they took any notice of the surrounding objects, should not have seen the flash, whose roar first awoke them into the use of their eyes, is not half so wonderful as that several learned men should regard the forgetfulness of such terror and stupidity as an evidence that no flash could be seen" (p. 233). Again, Arago wrote of this stroke that it showed "undeniably the principal effects of an ordinary stroke of lightning" (*Essays*). And on perusing the details of this incident, which I have given later on (No. 915), the reader will be able to see for himself that among the undoubted accompaniments of the stroke were traces of burning and the detonation of a thunderclap. So far, then, as I can see Mahon's theory of "returning" or upward induced strokes is not borne out by the fact on which he mainly founded it, has never since been confirmed by any single additional fact, and is totally opposed to electrical law. The idea of looking on these upward strokes as induced ones seems to me to have been simply an ingenious effort to explain away the clearly evinced upward action of an ordinary lightning stroke. It is noteworthy that in 1809 Mr. T. Henry, F.R.S., alluding to the remarkable Swinton case (No. 43, Mr. Chadwick's house, August 1809), calls the lightning stroke that (admittedly) then happened a "returning stroke" in order to express and account for its upward direction. See also Incidents (188) and (251).

Adams.—In 1794 Mr. George Adams, Mathematical Instrument Maker to his Majesty, published his *Lectures on Natural and Experimental Philosophy*. He says:—"In the discharge of the Leyden Jar it was found by experiments of Mr. Atwood of Cambridge that the two electricities rush into union from opposite directions." * * * "He made an exhausted receiver part of the electric circuit, and on using such charges as were not sufficient to form an explosion, he found the electric light proceeding in opposite directions from the parts communicating with the vitreous and resinous surfaces" (p. 351). Adams says that Symmer's plain and simple experiment "obviously suggests the existence of two currents proceeding in contrary directions," that it accords with the experiments of Atwood and Volta, and is in direct contradiction to the Franklinian theory of excess on the one side and deficiency on the other. He then continues:—"When a jar is charged very high, the electricities will often, in their endeavours to unite, force a hole through the jar and push out the coating on both sides, sometimes melting it; the burr of tinfoil protruded from the middle of the glass strongly indicates that the two electricities meet at the middle of the glass" (p. 352). Again he says:—"You have seen that the electric powers never become sensible to us except when they are separated, and then chiefly in their passage from one body to another in opposite directions; and that an equal quantity of a different power must be conducted from the earth to

the cloud to produce lightning." * * * "When one of these highly electrified clouds approaches so near to the earth as to exchange powers with it, then is the damage done to those things through which the exchange is made" (pp. 370-1). And again:—"In great thunderstorms there is a portion of the earth under the cloud which is electrified thereby with the contrary electricity; those objects therefore which form the most perfect conductors between the clouds and that portion of the earth will most probably be struck, as being the readiest way by which the two opposite powers can unite and restore the electrical equilibrium both in the cloud and the earth, one part of the flash ascending from the earth, the other descending from the cloud. Let us suppose a cloud vitreously electrified to be formed over a certain part of the earth's surface; the electric power of the cloud first separates that of the atmosphere," * * * "the surface of the earth then begins to be electrified and the powers therein to be separated, and a continual effort is made by the contrary electricities to unite between the earth and the cloud. If those causes which first produced the electricity still act, the power becomes inconceivably great, and the flashes in uniting will tear every thing to pieces that resists their passage" (p. 374). In these passages, Adams, by the application of Symmer's theories to lightning strokes, deduces in a clear and unmistakeable manner the upward direction of their force.

Singer.—In 1814 Mr. George John Singer published his *Elements of Electricity and Electro-Chemistry*, and makes the following allusion to the upward direction of lightning strokes:—"Lightning is occasionally discharged from the earth to the clouds," * * * "and many instances are on record in which the basement storey has sustained severe injury, the electric charge being divided and weakened as it ascended" (p. 231).

Thomson.—In 1840 Dr. Thomas Thomson, F.R.S., in *An Outline of the Sciences of Heat and Electricity*, says:—"Every person who has seen an electric spark must be aware that the passage is so instantaneous that it is impossible to say from which point it proceeds, or to which it goes." * * * "The two electricities are attracted towards each other, advance at the same instant from each of the charged bodies, and uniting together somewhere between the knobs, all symptoms of electricity are at an end." * * * "If the spark be very long the middle part of it is not illuminated at all, or only very slightly. Now this imperfectly illuminated part is obviously the spot where the two electricities unite, and it is in consequence of this union that the light is so imperfect." Here, again, we submit that Symmer's great theory is very clearly enunciated.

Lunn.—Writing (about 1840) in the *Encyclopædia of Experimental Philosophy*, the Rev. Francis Lunn, A.M., F.R.S., says:—"It is evident, upon ordinary electrical principles, that if two clouds, or one cloud and the earth, be oppositely excited and charged, the spark and the discharge may either pass from the cloud to the earth or from the earth to the cloud, as circumstances to us imperceptible may direct" (p. 9). Here Symmer's law is controverted. Mr. Lunn manifestly holds the general opinion that the direction of the stroke is from the so-called positive plate to the so-called negative plate, forgetting that the terms positive and negative are merely arbitrary expressions, convenient for elucidating the actions of currents, but quite devoid of physical signification. But he allows that a stroke of lightning may sometimes ascend; and that admission is noteworthy, although (like Franklin's opinion) it may be based on wrong data.

Harris.—The next writer whom I quote is Sir William Snow Harris, F.R.S.; but it should be well understood that he was probably very far from allowing the existence of an upward force in lightning strokes, for he expressly endeavours to account for the manifestations of this force by attributing to the supposed descending lightning a "terribly expansive power." In his detailed description, however, of the effects of the stroke (No. 951) at St. Martin's Church (London) in July 1842, he uses the same very remarkable expression that Mr. Delaval had employed in describing the injury to St. Bride's Church. Harris says that the clock-room floor of St. Martin's spire was left "as if blown up by gunpowder" (*Thunderstorms*, p. 80). Perhaps these unconscious testimonies to the truth of a certain theory by its opponents are even more convincing than the conscious evidence of its advocates would be.

Kaemtz.—In 1845 Herr L. F. Kaemtz, Professor of Physics at the University

of Halle, published his *Complete Course of Meteorology*. This was translated by Mr. C. V. Walker, F.R.S.; and it probably forms one of the most instructive and copious treatises on meteorological science that has ever been written. He says:—"There are numerous instances of lightning moving from below upwards." * * * "The spark probably leaves both bodies at once." He states that in the case of two clouds, he has actually witnessed this action of the lightning spark (p. 347).

Pouillet.—In 1847 the well-known French philosopher Pouillet published his *Elémens de Physique*, and thus alludes to the question of the direction of lightning strokes:—"Autrefois, on discutait beaucoup sur la question de savoir si la foudre tombe du ciel, ou si elle s'élève de terre vers les nuages; c'était une sorte de dilemme auquel on croyait ne pouvoir échapper; mais ce que nous avons dit précedemment montre, d'une manière assez evidente, que jamais la foudre ne tombe et que jamais elle ne s'élève; car il n' y a jamais translation du fluide électrique de l'un à l'autre des deux points extrêmes de l'éclair" (I. p. 548). In this passage M. Pouillet, in his just condemnation of the idea of the transference of a fluid, seems to avoid investigation into the manifest fact of the presence of a force, and consequently into the question of the nature and direction of that force.

Sturgeon.—On March 21st, 1848, Mr. William Sturgeon read a paper on lightning before the Literary and Philosophical Society of Manchester. One of the principal points on which he laid stress was the fact that objects were frequently struck obliquely at their central and lower portions, whilst their upper parts were not touched. He says that, in 174 cases (mentioned by Snow Harris) of ships being struck, in not more than 44 did the top-gallant masts suffer. He alludes to the idea once entertained by Franklin, that discharges were constantly upwards; but he does not agree with it.

Arago.—In the *Meteorological Essays* of the renowned French philosopher François Arago, translated by Lady Sabine, and published in England in 1855, the following important opinion (after reference to the Coldstream incident) is enunciated:—"I therefore admit without reservation the existence of ascending thunderbolts. I know that physicists of the first rank do not believe in it, and that they would even disdain to enter into any discussion on the subject; but facts must be held superior to the most imposing authorities" (p. 176).

Nasmyth.—In 1856 Mr. James Nasmyth, F.R.A.S., stated to the British Association that according to his observations "the form of lightning as exhibited in nature was simply an irregular curved line, most generally shooting from the earth below to the cloud above." * * * "He had never observed the zig-zag forms usually represented in works of art. "In the majority of cases he had observed that the course of the flash was from the earth upward to the heavens" (*B. A. Report*, 1856, *Trans. p.* 14).

De La Rive.—M. Auguste De La Rive, of the Geneva Academy, published in 1858 an English translation (by Mr. C. V. Walker, F.R.S.,) of his *Treatise on Theory and Practice*. He says:—"The transports of ponderable matter by lightning" * * * "are only an indirect consequence of the electric discharge; and we cannot deduce, as one is sometimes tempted to do, from the direction of a transport brought about by lightning the direction of the movement of the meteor itself. The question of descending and ascending lightnings no longer remains; and we can no longer conclude, as philosophers formerly did, that the lightning is ascending because it has raised a pavement," * * * "when once it is proved that all these circumstances are indirect effects of the discharge" (III. p. 143). M. De La Rive's argument would have been materially elucidated if he had stated what he meant by an "indirect" effect; and it would have been greatly strengthened if he *had* proved "that," according to his interpretation of the term, "all these circumstances" were "indirect" effects of the discharge. But both interpretation and proof are conspicuous by their absence; and it seems probable that M. De La Rive (like M. Pouillet) is confusing the question of fluid or matter with that of force.

Ferguson.—Dr. Robert Ferguson, of the Edinburgh Institution, in his work on *Electricity*, published in 1866, says:—"Wheatstone's experiment shows that the discharge of a Leyden Jar proceeds from both coatings at once, and ends in the middle." * * * * "Matteucci found by experiments with

laminæ of mica placed between charged metal plates that the discharge of the plates began simultaneously at each, the laminæ next the plates being charged with their electricities respectively, whilst those in the middle were without charge" (p. 66). Here again (as in the cases of Adams and Thomson) we have notable testimony in favour of the soundness of Symmer's views, and in harmony with the meteorological facts recorded by Kaemtz and Nasmyth.

Ganot.—Ganot, in his well known *Eléments de Physique* (translated by Dr. Atkinson), published in 1868, says:—"Lightning[1] in general strikes from above, but ascending lightning is also sometimes observed; probably this is the case when, the clouds being negatively, the earth is positively electrified, for all experiments show that at the ordinary pressure the positive fluid passes through the atmosphere more easily than negative electricity" (p. 831). Ganot thus holds the same view as Lunn, and treats the explosion of a condenser as a motion of a fluid. The last portion of the quotation, though a little obscure, is apparently in direct contradiction to Symmer's precise experiments made more than 100 years before.

Johns.—Writing to *Nature* in September 1871, the Rev. C. A. Johns, F.L.S., gives an account of a coachman, driving a gentleman's carriage along a turnpike road near Mr. Johns' house, being killed by an upward stroke of lightning, which shivered the man's felt hat into fragments. Mr. Johns also states that during the same storm he watched the lightning from his house, and every flash he observed was double, composed, as he imagined, of an ascending and a descending stroke. There seemed to be no difference of time between them—each appeared simultaneously. Mr. Johns also thought that when persons are killed by firesides in houses the lightning has not descended the chimney at all, but has ascended from the earth. All my researches lead me to believe that Mr. Johns' reasoning is thoroughly sound; and the meteorological evidence he adduced in favour of Symmer's theory is certainly noteworthy.

Graves.—In 1872 Mr. James Graves, writing to the *Journal of the Society of Telegraph Engineers*, makes the following remarkable communication (quoted in the condensed form in which the Society published it):—"People always speak of lightning falling, and never of its rising or ascending, which must often be the case." * * * "Lightning is the joint work of the positive and negative electricity. When the proper conditions obtain between the earth and the cloud for the production of a flash, then both the positive and negative exert their utmost to approach each other, selecting the easiest available channel, such as trees, bell wires, church steeples, &c." (p. 413). Clearly Mr. Graves's views are exactly in accordance with Symmer's well-founded theory; but his communication seems to have been but little noticed.

Tait.—Professor Tait, F.R.S., in his lecture at Glasgow *On Thunderstorms* in 1880, made the following allusion to the subject we are discussing:—"The motion of a flash of lightning cannot be detected; hence when people say they saw a flash going upwards or downwards, they must be mistaken. It is an optical illusion." It is certain, however, that if the *traces left by it* are scientifically examined, the direction of the force of the explosion can be detected, and that is the point which has been so much ignored.

Parnell.—In a work completed in April 1881, but not published till 1882, after reasoning on the incidents adduced by me (then only eighteen in number) showing an upward direction in the force of lightning strokes, and after discussing the question from the aspect of admitted electro-statical law, I stated as follows:—"In the case of the lightning electric spark we have two electricities, positive and negative, lying respectively on either side of the great gap formed by the atmosphere. The combined force of the two potentials has accumulated to that stage where the capacity of the gap is no longer able to restrain their fierce embrace; but there is no reason for supposing that positive has at this time more attraction for negative than negative has for positive. The conclusion, then, seems irresistible that if there is any element of time in the case at all, the lightning spark leaves the two plates, the earth and the clouds, simultaneously, and coalesces half-way between; and this would result in an invariable upward direction of the stroke immediately above the surface of the ground" (p. 166). When I wrote the above I was unaware of Symmer's experiments,

1 Dr. Atkinson appears to have translated *foudre* as "lightning."

and I had not seen the writings of Franklin, Priestley, Beccaria, George Adams, Thomson, Nasmyth, Ferguson, or Johns.

Damage to Trees.—I shall conclude these extracts with two interesting notes on the subject of trees damaged by lightning strokes. Professor J. H. Tice, of St. Louis, Mo, U.S.A., says that "in his examination of trees that had been struck, in nine cases out of ten no trace could be found of the lightning entering the earth, but that the bottom of the tree showed that the force was from the earth upward" (*Chambers' Co. Pamphlet*, 1882, p. 16). And Professor Colladon, of Geneva, states that "when lightning strikes a tree it leaves very few marks of its passage on the upper part and middle of the trunk." * * * "It is no uncommon thing to find the *lower part of a tree literally cut by the lightning*, while the upper portion and the higher branches seem to have hardly suffered at all" (*Times*, August 22nd, 1883).

I now proceed to submit the details of 278 instances, the records of which demonstrate with more or less precision the existence of an upward direction in the force of the stroke. These incidents are taken from the collection of 1,147 cases already mentioned. Of the remaining 869 cases, in 868 of them no indication of the direction of stroke has been recorded, and in 1 only is evidence given of a downward direction. This incident is inserted at the end of the upward cases. In these cases it will be noticed that in the majority of instances the proof of the upward force of the stroke is to be found in the action of projecting, transporting, dispersing or scattering. Some of these proofs are by no means so strong as others.[1] But in every case of alleged scattering, however scanty may be the details or weak the evidence, I have felt that I was justified in bringing it forward. For it seems to me quite impossible, from a mechanical point of view, for a downward stroke to exercise any scattering or dispersing power; whereas, the essential sign of an upward explosion or force is the projection to a greater or less distance of the substances burst or struck by it. The reader can, of course, form his own judgment on each case according to the testimony adduced. It may here be mentioned, that although the whole list has been compiled primarily with the view of illustrating the direction usually taken by lightning strokes, the details will also be found to furnish important testimony as to the nature of these strokes, and especially in regard to the characteristic of mechanical force upon which I have already dwelt. (The numbers given to the following incidents have reference to my complete list.) It should be noted that only such details as bear on the subject of the paper are recorded in the following list.[2]

(III.). Upward Strokes.

(35). July 3rd, 1725. Mixbury, Northamptonshire. A shepherd and five sheep killed. Near feet of shepherd were two round holes about 3 ft. deep and 5 ins. in diameter, and growing narrower downwards. Near one of the sheep (the only one wounded) the ground for nearly 2 yards around was "torn up." The shepherd's clothes and shirt were torn into small pieces. "From the "girdle downwards they were carried away entirely and scattered up and down "the field." The soles of his shoes were rent off and his hat torn to pieces. "The iron buckle of his belt was thrown 40 yards off." [*Phil. Trans*. XXXII., 366. H. A. 7, 104. Rev. J. Wasse, Rector of Aynho, near Mixbury.]

(42). About 1750. Funzie, Fetlar, Scotland. A rock of mica-schist, 105 ft. long, 10 ft. broad, and in some places 4 ft. thick, was torn from its bed and broken into three large pieces and several lesser ones. One piece 26 ft. long, 10 ft. broad and 4 ft. thick, was simply turned over. Another piece 28 ft. long, 17 ft. broad and 5 ft. thick, was hurled across a high point to a distance of 50 yards. Another piece 40 ft. long was thrown still further. [*Arago* 86.]

(43.) August 6th, 1809. Swinton, Eccles, near Manchester. The house of Mr. Elias Chadwick. Attached to it was a coal shed built of brick and

[1] There are in my opinion twenty-two of those weaker cases.

[2] Thirty cases only are printed of the 868 furnished by Col. Parnell. The others are, however, preserved at the Office of the Society, and may be seen by any one wishing to examine them.—Editor.

hydraulic lime mortar, supporting over it a water cistern formed of large stone flags. The whole shed was about 18 ft. long, 8 ft. broad and 11 ft. high above the ground. The foundations and bottom of the shed were about 1 ft. below the ground. The walls were 3 ft. thick, and were strengthened by bond timbers. In the shed at the time was about one ton of coal. A "tremendous explosion" occurred during the thunderstorm, and the outside wall of the shed was removed from its upright position to one slightly inclined (but with copings intact), with one end 9 ft. distant and the other 4 ft. distant from their respective original positions. The bond timbers were forced to a greater distance than the brickwork and seemed scorched. The wall seemed lifted from its foundations, and the portion removed contained 7,000 bricks. Including some walling thrown down the weight of material displaced was about twenty-six tons [*Mem. of Lit. and Phil. Soc. Manchester*, 2nd Series, II. 259. Mr. Matthew Nicholson writing to Mr. T. Henry, F.R.S.]. NOTE.—Mr. Henry deemed that this was a "returning stroke," like that at Coldstream (15), *i.e.* a stroke from the earth to the cloud.

(44). JULY 11TH, 1852. CHERBOURG. The ship *Patriote*. Mizen mast split for a length of 80 ft., and a piece 6 ft. 6 ins. long, nearly 8 ins. square at one end, and pointed at the other, was thrown against some oak timber planking 262 ft. 6 ins. distant, which it struck at its thick end and penetrated to the extent of half its length. [*Arago* 88.]

(115). AUGUST 6TH, 1879. TROLLEY BOTTOM, FLAMSTEAD, NEAR LUTON. The "Wheatsheaf" public house. The wooden chimney piece in a room on the ground floor was slightly moved, "and a bottle of ink which stood there was thrown with some violence to the ceiling." [L. R. C., Mr. J. E. Groome (the landlord).]

(188). AUGUST 21ST, 1851. Jacksonville, U.S.A. A son of Mr. R. Yates was killed about 80 yards from his home. A hole 3 ins. in diameter was pierced through the front of the crown of his straw hat. "Most of the straw was carried entirely away, and around the edges of the hole all the straws were pointing upwards." [*Am. Journ. Science*, XIII. 134, 1852. Prof. W. Coffin, of Illinois College, Jacksonville]. NOTE.—Professor Coffin adds that the appearance of the hat denotes that the boy was killed by a "return stroke."

(196). JULY 1ST, 1826. GREAT MALVERN, NEAR WORCESTER. A shelter hut of rough masonry on a high ridge above the village. A large crack was made on west side of hut extending from near the ground to the frame of a small window, above which the iron roof was a little indented. The fragments of stone from the wall were all on the west side of the house. The thundercloud approached from the west. (The narrator inferred from the two last circumstances and also from the appearance of the rent, that the stroke was upward. The *Encyclopædia Britannica* (8th Edition, p. 583) calls this incident "one of the most interesting cases of the ascending bolt" on record. [*Edin. Journ. Science, N.S.*, X. 83. Mr. John Williams.]

(251). MAY 6TH, 1830. ROUNDHAY PARK, NEAR LEEDS. An ash tree struck. Mr. Howard, F.R.S., says:—"The appearances which I examined indicated rather a returning stroke than one from the clouds." The tree was split through the whole length of the stem (about 8 ft.) in several rifts. The bark was thrown off all round from within 1 ft. of the bottom to near the insertion of the boughs, and there was a score in the remaining bark connecting the bare part with the ground. [*Howard*, XXX. 353. Mr. L. Howard, F.R.S.]

(253). JUNE 11TH, 1849. EDMONSTONE, NEAR EDINBURGH. Grounds of Mr. Wanchope, on the Dalkeith Road. The trunk of an oak tree 14 ft. in girth was rent from top to bottom. "A large mass from the northern side of the tree was driven out and carried through the air 127 ft. in the direction of the magnetic meridian, West-north-west. Its weight was 2¼ cwt." The main stem was entirely denuded of bark, which was scattered widely around. The roots were found considerably split and blackened. [*Brit. Assoc. Report*, 1850, p. 13. Professor Phillips, F.R.S.].

(279). JANUARY 25TH, 1757. LOSTWITHIEL CHURCH, CORNWALL. Above 20 ft. of the upper part of spire were thrown down and dispersed in all directions, and some pieces were found at the distance of 200 yards. The vane was thrown down and bruised. Its socket was rent open "as if it had been burst by gunpowder, and in such a manner as could not well be occasioned by the fall." [*Phil. Trans.* L. 198. Mr. John Smeaton, F.R.S.].

(288). FEBRUARY 18TH, 1770. SUNDAY. ST. KEVERNE'S PARISH CHURCH, CORNWALL. During morning service. The vicarage seat near the reading desk was torn into many pieces, and a large piece of oak near it was thrown to a distance of 20 ft. The vicar's sister, sitting on the vicarage seat, was knocked down senseless. She had pattens on, and the wooden part of one of them was broken into three pieces. Portions of it and of her shoe were burnt. The lower parts of her body, with her stockings, apron and petticoats were burnt. The spire was rent. "The stones were thrown from the spire on the tops of many houses in the Church Town." One stone that had fallen through the roof of a house was found to weigh 14 lbs. The stones were scattered in all directions. Some of them, "not very large, were found but a little short of a quarter of a mile." [*Phil. Trans.* LXI. 71. Rev. Anthony Williams, Rector of St. Keverne's.]

(304). JUNE 8TH, 1878. ASHFORD, KENT. A farm labourer standing under a willow tree was struck. The tree was found to be partly denuded of bark, and the man's boots were at its foot; but he himself was lying on his back, 6 ft. off, quite naked except for a part of the left arm of his flannel vest. He was conscious, but much burnt all over his body and his leg was badly broken. "The field around was strewn with fragments of the clothing." The right boot was much torn, and the sole was rent and burnt. The left boot was torn and twisted into fantastic shapes. The man stated that he was enveloped in a blinding light, "and was hurled into the air, coming down on his back all of a crash and never losing consciousness." Along each thigh and leg was a broad indurated band of burning. [*Journ. Soc. Arts.*, Dec. 1879, p. 65. Dr. G. Wilks, of Ashford.]

(348). JULY 26TH, 1849. WEST STREET, WHITECHAPEL, LONDON. In front of a house on the south side of street, was a wooden spout forming the lower portion of a rain waterpipe. The stroke rent off a piece of the spout 7 ft. long, and "hurled it with great violence into the back yard of one of the opposite houses which abutted on the north side of the street." [*Phil. Mag.* 35, p. 161. Mr. Radcliff Birt, writing from Bethnal Green.]

(361). MAY 1ST, 1862. MOREDUN, NEAR EDINBURGH. A large ash tree on the grass lawn at Mr. D. Anderson's house. A portion of the tree on its west side 2ft. broad and 6 ins. deep, extending from 3 ft. above the ground to the top, was entirely torn away. The fragments were thrown to various distances, some as far as 212 feet. One piece 6 ft. long and about 6 ins. in diameter was thrown to a distance of 180 ft. The pieces were about 120 in number, and most of them varied from 6 to 8 ins. in length. They were dispersed all round the tree, and several had their ends stuck deep in the ground. "The pieces, as they now lie scattered about all denuded of their bark, have more the appearance of being blown into their present grotesque positions with gunpowder than by a stroke of electricity." [*Edin. New Phil. Journ.* Vol. 16, p. 297. Mr. McNab.]

(362). AUGUST 14TH, 1858. A HILL IN SCOTLAND AT THE NORTH SIDE OF THE SPEY. At the top was a bare conical point of red granite, 30 ft. in circumference, and about 6 ft. above adjacent soil. A trench was ploughed in the hill-side between a peat moss at the bottom and the rock in question. Every stone within this trench was smashed. A hole was made about 4 ft. deep and 16 ft. in circumference close by the rock. The latter was shattered into pieces, and "several of them weighing 2 or 3 cwt. were thrown to a distance of from 20 to 30 yards." [*Edin. New Phil. Journ.* 9, p. 125. Dr. James Stack.]

(396). JULY 24TH, 1880. MOYLOUGH, CO. GALWAY. A field near Moylough Church. A long branching furrow was *upturned* in the ground as if by a plough, a deep hole being bored at each end of six terminal branches, and "the earth round the holes being raised as if pushed up from below. Tufts of grass were scattered 30 and 40 yards from the place." [*Nature*, August 12th, 1880.]

(586). PRIOR TO 1875. A RAILWAY IN ENGLAND. During a thunderstorm a driver was just starting an engine when "a flash of lightning struck the trailing axle, passed up through the foot plate and struck the regulator handle, splitting it right up from bottom to top." [*Eng. Mech.*, September 24th, 1875. Mr. J. H. Chalmers.]

(832). JULY 11TH, 1806. MORETON CHURCHYARD, DEVONSHIRE. "The earth was torn from several graves, and human skulls thrown to a considerable distance." [*Ann. Reg.* 425.]

(838). AUGUST 8TH, 1806. BUSHEY HEATH, NEAR RICKMANSWORTH. A woman when running into her cottage for shelter was killed. Her limbs were

torn off, and "one of her legs was found 20 yards from her body." [*Ann. Reg.* 433.]

(872). JUNE 3RD, 1835. LONGSIGHT, NEAR MANCHESTER. Near the "Shakespeare" Inn. A man named Richard Shuttleworth was struck dead. At the moment when he was killed, several persons "witnessed explosions of electric fluid at different points on the road, just as if so many pistols had been fired out of the ground. One of these explosions appeared to have taken place under Shuttleworth's right foot." The shoe heel was torn asunder and the upper leather torn out. The right stocking was much burnt and a long gaiter was torn open. His person from the right foot up to the head had marks of scorching. His hat was burst outwards on each side of the head. One side of his umbrella "was perforated by a number of small holes as if a charge of small shot had been fired through it from the inside, the fibres of the cotton showing very clearly in which direction the perforations had been made." [*Ann. Reg.* 89.]

(912). JANUARY 11TH, 1761. CHURCH AT BREAG, CORNWALL. Tower rent almost from top to bottom. South-east pinnacle split into a thousand pieces and scattered all over the spacious churchyard. "The lightning must have passed directly up the tower, through the midst of the wall, the outside of which" * * * "is quite bulged out between the first and second ring." * * * "The stones of the pinnacles and battlements were scattered in all directions; one of at least 150 lbs. weight fell on the top of a house about 60 yards to the south, another was cast full 400 yards to the north, one very large one to the south-east of the church." [*Phil. Trans.* LII., 507. H.A., 11, 621, Rev. W. Borlase, M.A., F.R.S.]

(915). JULY 19TH, 1785. COLDSTREAM, N.B. Just across the Tweed. James Lauder sitting on fore part of a cart driving two horses. The cart was loaded with coal. Lauder and the two horses were killed. The cart was overturned. Many pieces of coal were thrown out to a considerable distance all round the cart. The hair of the horses "was much singed over the greater part of their bodies, but this was most perceptible on the belly and legs." Mr. Brydone picked up fragments of Lauder's hat which had been torn into innumerable small pieces." * * * "Part of his hair was found strongly united to some of the fragments which had composed the crown of the hat." His clothes were torn to pieces. About 4½ ft. behind each wheel was a circular hole about 20 ins. diameter, whose centre was exactly in the track of the wheel. "The earth was torn up as if by violent blows of a pickaxe," and the small stones and dust were scattered on each side of the road. A witness observed "the dust to rise at the place." Mr. Brydone refers to the place as "this electrical mine," and he says:—"From the whole it would appear that the earth had acquired a great superabundance of electrical matter which was every where endeavouring to fly off into the atmosphere." [*Phil. Trans.* LXXVII. Mr. Patrick Brydone, F.R.S.]

(925). SUMMER 1787. TACON, NEAR BEAUJOLAIS, FRANCE. Two persons sheltering under a tree killed. Portions of their hair were found in the top of the tree, and parts of their sabots among the branches. [*Arago*, 175.]

(926). AUGUST 29TH, 1808. PARIS. A workman in a pavilion with a thatched roof, near L'Hôpital de la Salpetrière, killed. Portions of his hat were found inserted in the ceiling. [*Arago*, 175.]

(942). JUNE 18TH, 1829. TOOTHILL, ESSEX. (Between Epping and Ongar.) A windmill. At the ground near the iron braces under the stairs "it (the stroke) tore up the stones and gravel." There were some heavy weights on the lower floor near the western side of the mill. "Here it tore up a large space of the floor, the weights were ejected into the yard to a considerable distance, and the boards were forced off as before with great violence and thrown in every direction." "The roof it (the stroke) completely drove off and nearly all the boards round the mill as far as the floor." * * * "Such was the violence of the explosion that a great many pieces of the boards and large fragments of the mill were thrown into the adjoining fields to an amazing distance, and some of them must have ascended to a great height in the air, as they were observed sticking upright in the hard ground as if driven by a pile driver." [*Howard*, 321. Mr. Thomas Squire, of Epping, a friend of Mr. Howard.]

(1012). MAY 31ST, 1875. CONCORDIA, ARGENTINE REPUBLIC. The Brazilian Vice-Consul's house. With a flagstaff 18 ft. high over the front door. Paving tiles torn up at the foot of the lower bolt of door. Flagstaff was shattered longi-

tudinally into several pieces. One piece 10 ft. long and 2 ins. broad was thrown on the roof of a house 50 yards distant. [*Tel. Journal*, Sept. 15th, 1875. Mr. J. H. Blomfield, of Concordia.]

(1017). FEBRUARY 25TH, 1875. PAIGNTON, TORBAY. A house on a prominent headland close to the sea, with a flagstaff in front, 50 ft. high and stayed by four iron wire ropes ending at the ground in mooring chains. At the point where each mooring chain was fixed, a hole about 12 ins. deep was formed in the ground. Five scores were ploughed in the ground all roughly radial to the flagstaff. Flagstaff above wire stays was split into pieces. "Fragments of the shivered wood were found 150 ft. to windward, measured distance." [*Quarterly Journ. of Met. Soc.*, Vol. II. 1875, p. 429. Mr. D. Pidgeon, owner of house and witness.]

(1032). AUGUST 1ST, 1846. ST. GEORGE'S CHURCH, LEICESTER. The steeple was burst asunder and parts of it were thrown in every direction. "Fragments of stone were found several hundred feet from the spire, and lying in all directions from its centre." From measurement and calculation it was estimated that no less than 100 tons of stone were blown down, and that the average distance to which this mass was projected was 30 ft. The black varnish on the clock faces that were struck "presented the appearance of having been swept over by a terrific current of air." [*Journ. Soc. Arts* (1846-7), 86. Mr. E. Highton, C.E.]

(1080). MARCH 13TH, 1844. COAST OF IRELAND. A martello tower. An endless iron racer 4 ins. broad and 1½ ins. thick was laid on a banquette or step 18 ins. higher than the roof of the tower, and intended for the wheels of the gun platform to move on. The roof was flat, of an oval shape, and surrounded by a thick stone parapet 4 ft. higher than the banquette, parallel to the racer and about 1 ft. distant in front of it. Close to the foot of the banquette was the mouth of a lead rain-water downpipe. Between the mouth of this pipe and the racer the stroke broke out from the banquette a piece of masonry weighing about 4 lbs., "which it hurled over the parapet (4 ft. high) to a distance of about 50 yards in front." [*Aide Memoire to the Mil. Sciences*, I. 391. Colonel R. J. Nelson, R.E. Sketch given of roof of tower.]

(1147). FEBRUARY 22ND, 1884. ST. MARY'S CHURCH, KIDWELLY. The spire was shattered. Some stones were "hurled a distance of 300 yards." The roof on north-west side of nave was completely riddled by falling *débris*, and some pews in the church were thereby "literally smashed to matchwood." At a house in Causeway Street, between which and the Church the Town Hall intervened, a stone 12 ins. long and weighing about 30 lbs. crashed through the roof and ceiling into a room where two men were sleeping, but they were not struck by it. The roofs of several other houses were also damaged. [*Western Mail*, February 23rd, 1884. *South Wales Daily News*, February 23rd, 1884.]

(IV.). ALLEGED DOWNWARD STROKES.

The following is the solitary incident which I have been able to obtain in evidence of the existence at the surface of the earth of a downward force in lightning strokes.

(185). JUNE 15TH, 1873. KANSAS CITY, MO., U.S.A., Sunday afternoon. On the platform of a promenade at the "Amphitheatre," in the fair grounds, a young lady and a young gentleman were sheltering during a thunderstorm under an oak tree. They were 15 ft. from the trunk, and within 3 or 4 ft. of the overhanging boughs, when the stroke occurred. The description of the event commences with these words: "An electrical discharge sought them out on its way from the clouds to the earth." The record states that the plank on which the lady stood was found to be pierced like as by a musket ball, "the upper side of the perforation being smoothly depressed, while underneath it was jagged and enlarged." One of two white pine posts, 1 foot in diameter, supporting the beam under the planks, was split along its length, and the other one splintered, whilst the beam between the two was fissured. The lady was killed, the gentleman with her was crippled, and many of the spectators received a violent shock. The shoe of the lady was torn into shreds, the right foot had a well-marked groove on it; the body, hair, and clothes were burnt, and there was a red mark on the chin "as

if by a violent blow." No marks were found either on the trunk of the tree or on its branches." [*American Journal of Science*, VI. 157. Account by the Rev. Horace Hovey, M.A.]

I beg to submit the following comments on this narrative :—

(1). The account is not given on scientific authority.

(2). The words with which it commences appear to imply a preconceived opinion on the part of the narrator in regard to the direction of lightning strokes ; and it seems to be inferred to some extent by this gentleman, who was a minister, that the stroke was, as it were, purposely directed from the clouds, or from heaven, on these young persons, who were spending in a rather secular manner (for the platform seems to have been intended for dancing) their Sunday afternoon.

(3). If the stroke were really from above, the absence of any traces in the overhanging boughs of the tree, and the restriction of the principal effects of the stroke to the platform and the timbers below it, are very remarkable facts.

(4). Unless the narrator were present himself at the time (which is in the highest degree unlikely), he must have received the account from some other person, and it has therefore the more chance of being incorrect.

(5). When the lady was thrown down, surely such of the bystanders as were not affected by the shock must have crowded round to offer assistance, or to learn what had happened ; and it was probably only after they had walked over and trodden down the hole that is mentioned, that its existence and condition were observed. To such a circumstance as this would the "smoothly depressed" state in which the upper surface of the hole is alleged to have been found probably be due.

(6). But if the plank was of soft white pine, as appears to have been the case, is it conceivable that any sort of blow could have struck it either from above or from below without to some extent splintering or cracking the edges on both sides ?

(7). With the single exception of the "smoothly depressed" state of the upper side of this hole in the plank, all the circumstances of the stroke are in harmony with an upward direction of force.

(8). On the whole I submit that the evidence afforded by this case in regard to the existence of a downward force is by no means trustworthy.

(V.). SUMMARY.

That physical force, manifested in mechanical work, is one of the principal characteristics of lightning strokes, is a proposition which I think few persons, after considering the facts related in this paper, would be inclined to controvert. So far as my own investigations and studies have reached, I should be strongly induced (as I have already said) to class mechanical work as the *main* effect of these strokes. Experience appears to indicate that the more powerful the stroke, the less does it evince heat work ; and indeed all laboratory experiment and mathematical reasoning would appear to confirm the truth of this theory. It is well known that when an intense electrical discharge is transmitted through loose gunpowder, the latter is not ignited, but is merely scattered. The less we treat a lightning stroke as an electrical current, subject to the laws of batteries and machines, and the more we look on it as an electrical mine or explosion, the sooner I think shall we arrive at the laws of the source and action of geo-electricity, and of geo-dynamics. In regard to the question of the general direction of the force of lightning strokes, it seems to me that we are in a satisfactory condition. That there should be difficulty after careful and close research in obtaining even one single authentic case in history wherein the action of a downward

force can be proved, is in my opinion a vindication of the theory that holds these actions to be invariably upward. And that there should be forthcoming at least as many instances as 256 (nearly the whole of them being from the pens of those who conceived no other idea but that these strokes always descended) in which clear proof of an upward force is established, must I think be admitted to confirm the negative result just mentioned. I cannot imagine how the great number of neutral cases can be supposed to affect the question one way or the other, except that there is every reason to expect that, if the narrators had not been imbued with the popular preconceived notion on the subject, a considerable number of these records would probably have contained evidence on the side of the upward theory. Well, then, in my opinion the whole case stands thus: laboratory experiment and electro-statical law declare that the direction of a lightning stroke in regard to the ground ought to be towards the opposed plate of the electrical condenser, *i.e.* upwards. And a close research extending over several years into the manner in which Nature has acted in these matters, appears to me to demonstrate that these strokes actually have been upwards.

On the Reduction of Temperature Means from Short Series of Observations to the Equivalents of Longer Periods. By Dr. Julius Hann, Hon. Mem. R.Met.Soc.

[Read December 17th, 1884.]

I have recently had the honour to lay before the Academy of Science in Vienna the first part of an investigation into the climate of the Alpine districts of Austria, which has taken up a good deal of my time; and in it I have endeavoured to reduce the monthly and annual means of all the temperature observations from those districts for the interval from 1848 up to 1880, and in some places up to 1884, to the mean for the thirty years' interval 1851-80. This process was found indispensably necessary, even though the great majority of the stations which were available yielded results which were not directly comparable *inter se*. In this country, however, the observers are almost all volunteers and unremunerated, and consequently we possess a large number of records of short duration and for various periods. It is universally admitted that the reduction of mean values derived from short periods to one and the same period of longer duration is absolutely necessary for our climates. Temperature tables which contain only unreduced means from a number of records of short duration, and afford no materials for effecting their subsequent reduction to the uniform standard period, are comparatively of little value. The great work of the Smithsonian Institution on the Temperature of North America is not free from this grave defect, and therefore the state of our knowledge of the distribution of temperature in that continent is still far from satisfactory.

The process of reduction under consideration, which has been carried out

on an extensive scale by Wild in his great work on the Temperature of the Russian Empire, as well as by the Meteorological Office and by Buchan in their discussions of the Temperature of the British Isles, has been as yet applied only to stations which do not differ seriously in elevation. On the other hand, Dove, who is generally recognised, at least in German works, as the first proposer of this mode of reduction, as well as Hellmann more recently,[1] have remarked that the process is not nearly so trustworthy in a mountainous region, and that the limits of its applicability are uncertain.

Of late years the vertical distribution of temperature in the Winters of 1879-80 and 1881-2 has forced us to recognise the remarkable fact that while low temperatures and even severe cold prevails in the lowlands a mild temperature may exist even at a moderate elevation, and has impressed upon our minds the serious weight to be attached to the remarks above mentioned. The entire process of reduction rests on the assumption that over considerable areas the simultaneous deviations of temperature from its mean value are nearly constant, as well in sign as in amplitude. In other words, although the monthly and yearly means of temperature in different years may vary within wide limits, the differences of temperature between adjacent stations remain nearly constant for the same intervals of time.[2]

This condition is admittedly true for stations at a reasonably uniform elevation; but, on the other hand, as above stated, we know that frequently in the late autumn and early winter an anomalous distribution of temperature with height prevails, so that the temperature rises with the elevation and the differences between the upper and lower stations change their sign. The question then arises,—Is it admissible to apply the usual method of reduction to mountain stations?

It was necessary for me to find an answer to this question before I could carry out the reduction of the entire mass of data in my hands to the period 1851-80, and I took this opportunity of testing the whole principle of this reduction in general with regard to its accuracy and the limits of its applicability; and such an inquiry has, I believe, not been carried out before.

To this end I selected a considerable number of schedules of observations possessing the character not only of superior accuracy but of long duration, and determined the differences of temperature between the stations in pairs and for each individual month and each year. My object was to obtain as many combinations as possible as regards differences in distance as well as in elevation between the stations. I give here a portion of one of these tables as a specimen. Not less than fifty of such pairs were calculated.[3]

[1] *Zeitschrift der Osterreichischen Gesellschaft für Meteorologie*, Vol. X.

[2] Lamont (as early as 1839) seems to have been one of the first to point out this fact, and to base thereon the reduction of short period means to longer periods.

[3] At the same time I should remark that such tables of temperature differences were calculated for all Alpine stations as compared with central stations, in order to calculate the normal values for the period 1851-80 for the monthly and yearly means of the differences. This mode of calculation offers great advantages, for it enables one to detect the larger errors of observation or calculation, and affords a continual check on the correct-

KREMSMÜNSTER—VIENNA. DIFFERENCES OF TEMPERATURE CENTIGRADE.
Distance 55 Kilom. ΔH = 20 metres. Δ long. = 0°·11′. Δ lat. = 0°·46′.

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1875	−0°·2	−0°·6	−0°·1	−0°·8	−0°·4	−0°·2	−0°·8	−1°·1	−0°·9	−0°·7	−0°·8	−0°·3	−0°·6
1876	−0·1	−0·1	−0·7	−0·8	−0·8	−0·2	−0·9	−1·1	−1·8	−0·4	−0·4	−0·8	−0·7
1877	−0·4	−0·4	−0·7	−1·2	−0·6	−0·7	−0·6	−1·2	−1·5	−1·1	−1·0	−0·3	−0·8
1878	−0·2	−0·5	−0·6	−0·8	−0·5	−0·4	−0·3	−0·8	−0·8	−1·3	−1·2	−0·8	−0·7
1879	−0·1	−0·6	−0·6	−0·9	−0·7	−0·9	−0·6	−0·7	−0·9	−0·5	−0·4	−0·8	−0·6
1880	−0·4	−0·3	−0·5	−0·7	−0·8	−0·5	−0·7	−0·6	−0·7	−0·8	−0·9	−0·1	−0·6
1881	−0·5	−0·3	−0·5	−0·9	−0·7	−0·9	−0·7	−0·7	−0·7	−0·5	−0·3	−0·8	−0·6
1882	−0·4	−0·9	−1·0	−0·2	−0·9	−1·0	−0·8	−0·4	−0·9	−0·6	−0·8	−0·6	−0·7
1883	−0·1	−0·3	−0·6	−0·9	−0·5	−0·8	−0·6	−1·2	−0·4	−0·5	−0·6	−0·5	−0·6

The deviation of each difference from the corresponding mean was then determined, and a mean was cast from these deviations irrespective of their signs. In this way I determined the Mean Deviations of the Differences of temperature, or their Mean Variability, and thus obtained a measure of the accuracy of the mean values.

I had likewise calculated for more than 30 stations in the Alps, each yielding records for at least 25 years, the mean deviations or the mean variability of the monthly and yearly means of temperature, and so I was able at once to demonstrate the advantages which this mode of reduction offers in the way of increasing the comparability of the mean values.

The subjoined short table gives a summary of the variability of the monthly and yearly means of the temperature in the Alpine regions, and also instances of the variability of the temperature differences under different conditions.

COMPARISON BETWEEN THE MEAN DEVIATIONS (VARIABILITY) OF THE MONTHLY AND YEARLY *Means* OF TEMPERATURE AND OF THE *Differences* OF THE MEANS.

I. MEAN VARIABILITY OF THE MONTHLY AND YEARLY *Means* OF TEMPERATURE CENTIGRADE.

Months.	North Side of Alps.	High Alps.	S. Eastern Alpine Valleys.	South Tyrol.	Southern base of the Alps.
December ..	**2·55**	**2·22**	**2·53**	**1·62**	**1·70**
January ..	1·97	1·68	2·28	1·33	1·66
February ..	2·10	**2·03**	2·24	1·49	1·55
March	1·55	1·82	1·65	1·47	1·29
April	1·24*	1·28	1·27*	0·98	1·04*
May	**1·87**	**1·76**	**1·61**	**1·50**	**1·47**
June	1·01*	1·10*	0·88*	0·93*	1·02
July	1·29	1·37	0·97	1·14	0·98*
August ...	1·24	1·45	1·00	1·03	1·03
September..	1·11*	1·37*	1·01	0·98*	0·98*
October	1·29	1·70	1·58	1·12	1·29
November ..	1·64	1·72	1·59	1·23	1·25
Year	0·68	0·60	0·66	0·45	0·55

ness of the calculation itself and on the trustworthiness of mean values. It also gives facilities for discovering if any changes in the exposure, &c. of the instruments have taken place.

PROBABLE ERROR OF THE 30 YEARS' MEAN.

	°	°	°	°	°
Winter	0·35	0·31	0·36	0·23	0·25
Spring ...	0·24	0·25	0·24	0·20	0·20
Summer ..	0·18	0·20	0·15	0·16	0·16
Autumn ..	0·21	0·25	0·22	0·17	0·18
Year ..	0·10	0·09	0·10	0·07	0·08

II. MEAN VARIABILITY OF THE *Differences* OF TEMPERATURE BETWEEN THE STATIONS IN PAIRS.

	Group. I.	Group. II.	Group. III.	Group. IV.	Group. V.	Group. VI.	Group. VII.
Distance Kilom. Difference of Height Metres.	430 240	160 150	40 120	35 70	45 660	40 1540	50 1700
December ..	0°·98	°·86	°·42	°·27	°1·33	°1·68	°1·91
January	·87	·63	·38	·26*	1·13	1·72	1·38
February....	·96	·73	·40	·28	1·24	1·63	1·38
March	·71*	·43	·31	·31	·73	1·04	·81
April	·75	·37	·25	·30	·40	·52*	·41
May	·76	·47	·24*	·25*	·34*	·66	·32*
June	·52	·38	·31	·26	·39	·65	·38
July	·47*	·38	·32	·30	·42	·68	·41
August	·52	·37*	·28	·33	·33	·67	·48
September ..	·56	·42	·28	·36	·30*	·70	·52
October	·57	·41	·27*	·32	·49	·82	·73
November ..	·84	·52	·36	·26	·76	1·25	·87
Year....	·31	·24	·15	·13	·27	·39	·32

Group I. Bâle-Kremsmünster, Munich-Vienna. *Group II.* Krems-Munich, Krems-Vienna, Bâle-Altstätten, Vienna-Graz, Vienna-Budapest. *Group III.* Krems-Ischl, Krems-Linz, Krems-S. Florian, Krems-S. Georgen, Laibach-Rudolfswerth, Laibach-Krainburg, Laibach-Stein. *Group IV.* Vienna-Krems, Vienna-Mödling, Vienna-Guttenstein, Vienna-Kalksburg, Vienna-Hadersdorf. *Group V.* Klagenfurth-Sachsenburg, Klagenfurth-S.Lambrecht, Klagenfurth-Hausdorf, Klagenfurth-Steinpichl, Sachsenburg-Tarrach, Sachsenburg-Prägratten. *Group VI.* Obir-Klagenfurth, Obir-Laibach, Obir-Hüttenberg. *Group VII.* Schafberg-Ischl, S. Bernard-Geneva.

It will be seen at once from these tables how much less is the variability, and how much greater therefore the accuracy of the means of temperature differences, than of the mean temperatures themselves, for the same number of years. This is even more striking if we calculate the number of years which are requisite to reduce the probable error of the mean values to $\pm 0^\circ{\cdot}1$. The figures in the column Winter refer to an ordinary Winter month, *e.g.* December, January or February, and not to the mean of the Winter season; for similarly the other seasons.

NUMBER OF YEARS REQUISITE TO INSURE AN ACCURACY OF $\pm 0^\circ{\cdot}1$ CENTIGRADE IN MONTHLY MEANS OF TEMPERATURE.

Season.	North Side of the Alps.	High Alps.	South-eastern Alpine Valleys.	South Tyrol.	South Base of the Alps.
Winter	370	290	400	160	190
Spring......	180	190	170	130	120
Summer	100	130	70	80	80
Autumn	130	180	150	90	100

NUMBER OF YEARS REQUISITE TO GIVE AN ACCURACY OF $\pm$°·1 IN TEMPERATURE DIFFERENCES.

Distance Kilom.	Difference of Elevation. Metres.	Winter.	Spring.	Summer.	Autumn.	Year.
440	150	85	58	29	47	10
173	150	35	13	10	22	4
70	115	17	7	8	8	2·3
32	70	5	4	5	6	1

It is, of course, out of the question in our climate to think of attaining an accuracy of $\pm 0°{\cdot}1$ in the monthly means, inasmuch as it would require for the monthly mean observations of many hundred years in Winter, and even in Summer of nearly a century. We see, however, from the second short table that if the distance between the stations to be compared is 170 kilom., and the difference of levels slight (150 metres), then 35 years are sufficient to secure an accuracy of $\pm 0°{\cdot}1$ for a winter month, while 10 years are enough for a summer month. If we have a normal station, distant only 70 kilom. from the station to be compared, then 17 years will suffice even in winter, and as few as 8 in summer, to attain the desired accuracy of $\pm 0°{\cdot}1$ in the monthly means. We are therefore in a position by the aid of the mean differences of temperature to determine from corresponding years very accurate relative mean values for a large area of observation, so that we can depend on our temperature comparisons down to $\pm 0°{\cdot}1$. (I am naturally treating of the probable error due to the variability of temperature means, without reference to other sources of error.)

We must now consider the results when the difference in elevation between the stations is considerable. This we can see from the following short table:—

Stations.	E	ΔH	Winter.	Spring.	Summer.	Autumn.	Year
Hüttenberg-Graz	69	440	·47	·44	·47	·48	·16
St. Lambrecht-Graz	86	690	·72	·45	·42	·48	·24
Schafberg-St. Bernard..	532	700	·99	·92	·58	1·00	·24
Schafberg-Ischl	17	1310	1·76	·50	·46	·75	·35
Obir Laibach-Huttenberg	50	1510	1·53	·61	·60	·78	·35
St. Bernard-Geneva	88	2070	1·36	·54	·39	·67	·30

This shows us that, even with slight distances between the stations, when the difference of level is great, the variability of the temperature differences even in summer is very considerable.

If we calculate the number of years required to give an accuracy of $\pm 0°{\cdot}1$ in the mean differences when the differences of elevation are great, we obtain the following figures:—

NUMBER OF YEARS REQUISITE TO GIVE AN ACCURACY OF $\pm 0°{\cdot}1$.

Stations.	Winter.	Spring.	Summer.	Autumn.	Year.
Schafberg-Ischl	230	19	15	41	9
Schafberg-St. Bernard	73	63	25	74	4
Obir Group.	170	27	27	45	9
St. Bernard-Geneva	135	21	11	33	6·7

Even in these extreme cases the method of differences affords great advantages. In the summer half-year especially, even in short period records, their accuracy is very high. In winter, the probable errors are certainly more considerable, but they are always small when compared with the uncertainty of mean values.

It is very instructive to examine the comparison of the differences Schafberg-Ischl with those of Schafberg-St. Bernard. The last-mentioned station is distant 582 kilom. from the Schafberg, and the difference of level is 700 metres; and yet it is much better to deduce the normal monthly means in winter for the Schafberg by means of differences from St. Bernard than from Ischl, which is quite near at hand (distance 17 kilom.). For the same number of years the probable error for a winter month in the case of the St. Bernard is about one-half that in the case of Ischl. In the summer, on the contrary, it is much safer to calculate the normal means by the use of differences from Ischl. In organising a system of observations in any mountainous country, it is therefore of great importance to establish normal stations, that is to say, stations of the Second Order, where the observations will be continuous at different levels at least every 500 metres, and alternately in valleys and on peaks or mountain sides. The horizontal distance between the stations is not so important a factor as the difference in level and the similarity of situation.

The detailed tables in my paper give copious instances of the great influence exerted by the situation of the stations to be compared, over and above that due to their distances apart or their differences of level. I cannot enter into this subject fully, as it would require too much detail. I shall only give some instances of the deleterious influence, as regards the trustworthiness of the mean temperature differences, due to the circumstance that one of the stations lies in a valley which is abnormally cold in winter owing to the stagnation of cold air therein, while the other is at some height above it, and is not therefore exposed to this abnormal chilling action.

Localities.	Distance Kilom.	Difference of Level. Metres.	Variability of Temperature Differences.				
			Winter.	Spring.	Summer.	Autumn.	Year.
Graz-St. Lambrecht........	86	690	·72	·45	·42	·48	·24
Klagenfurth—St. Lambrecht	49	600	1·39	·51	·44	·67	·32
Klagenfurth-Hausdorf......	35	520	1·30	·42	·29	·42	·21
Klagenfurth—Steinpichl ..	28	640	1·16	·51	·29	·49	·20

The variability of the temperature differences between St. Lambrecht, Hausdorf, and Klagenfurth respectively, at the distance of about 40 kilom. and 500 or 600 metres difference of level, is about as great in winter as between Geneva and St. Bernard, which are distant 88 kilom. apart, and 2070 metres in vertical height. Although St. Lambrecht is nearly twice as far from Graz as from Klagenfurth, and the difference of levels is also greater, it is far safer to reduce St. Lambrecht to Graz than to Klagenfurth. In the latter case nearly four times as long a series of observations would be requisite as in the former, in order to secure equal accuracy. The reason is

that Graz is not subject to abnormal chills in winter, as is the case with Klagenfurth. In summer, however, *this* influence of locality disappears almost entirely. On the other hand, maxima of variability of temperature differences are developed by many other peculiarities of situation, as *e.g.* when one station lies on a lake or in a forest, while the other is not so situated.

Localities.	Distance Kilom.	Difference of Level. Metres.	Variability of Temperature Differences.				
			Winter.	Spring.	Summer.	Autumn.	Year.
Geneva—Bâle	115	130	·70	·39	·65	·59	·29
Milan—Riva	140	60	·69	·45	·47	·46	·29
Vienna—Guttenstein	51	260	·41	·43	·46	·47	·21
Vienna—Kalksburg ..	15	60	·33	·40	·42	·39	·20

Independently of such local conditions as have just been mentioned, we find that a clearly defined relation is traceable between the amount of variation of temperature differences and the distance or difference of level between the stations. It is therefore worth while to see if a formula can be found by which this relation can be reduced to a simple concise expression. To this end I took all the pairs of stations, except those in which the differences in local situation of the stations influence the variability to a serious extent, arranged them in groups according to horizontal distance and difference of elevation, and calculated for all these groups mean values for the variability of temperature differences (Vt) in winter, summer, and on the mean of the twelve months. I thus got eight or ten equations, from which I obtain by the method of least squares the constants of the formula

$$Vt = a + b\,\mathrm{E} + c\,\Delta\,\mathrm{H}.$$

Where E is the distance in kilometres.

ΔH ,, difference of elevation in hundred metres.

Vt ,, mean variability of temperature differences.

a, b, c are constants.

I then obtained

$$\text{Winter, } Vt = 0^{\circ}{\cdot}32 + 0{\cdot}00180\,\mathrm{E} + 0{\cdot}0617\,\Delta\mathrm{H}.$$
$$\text{Summer } Vt = 0^{\circ}{\cdot}25 + 0{\cdot}00086\,\mathrm{E} + 0{\cdot}0138\,\Delta\mathrm{H}.$$
$$\text{Mean } Vt = 0^{\circ}{\cdot}28 + 0{\cdot}00131\,\mathrm{E} + 0{\cdot}0283\,\Delta\mathrm{H}.$$

The unit of E is the kilometre of Δ H, 100 metres.

These formulæ reduced the sum of the differences between the observed and calculated values to zero, and furnish a simple answer to the questions:—

1. How many years' observations are required to determine with an accuracy of $\pm\, 0^{\circ}{\cdot}1$ the mean temperature differences between two stations at a given distance apart, and at a certain difference of level?

2. What are the limits for the useful application of the method of corresponding differences for the reduction to means for long periods? These limits of distance and difference of level are evidently reached, when by the

application the variability of the temperature differences is the same as the variability of the mean values themselves.

In order to give a convenient general answer to the first question, I have calculated the brief tables of which the following is an excerpt.

NUMBER OF YEARS REQUISITE TO ENSURE AN ACCURACY OF $\pm0^{\circ}\cdot10$ IN MEAN TEMPERATURE DIFFERENCES.

I. DIFFERENCE OF LEVEL = 0.

Distance........	Kilom. 25	Kilom. 50	Kilom. 100	Kilom. 200	Kilom. 300	Kilom. 400	Kilom. 500
	YEARS OF OBSERVATIONS NECESSARY FOR THE MONTHS OF						
Winter	10	12	18	33	53	77	107
Summer	5	6	8	13	19	25	33
Mean	7	9	12	21	32	46	62

II. DISTANCE = 0.

Difference of Level	Metres. 250	Metres. 500	Metres. 750	Metres. 1000	Metres. 1250	Metres. 1500	Metres. 2000
	YEARS OF OBSERVATIONS NECESSARY FOR THE MONTHS OF						
Winter	16	29	44	63	85	110	172
Summer	6	7	9	11	13	15	19
Mean	9	13	17	22	29	35	51

Calculated by the formula of Fechner

$$\text{the probable error} = \frac{1\cdot1955}{\sqrt{2n-1}} \times \text{mean deviation}$$

n number of years, from which the mean deviation has been determined.

If n_1 is the number of years which are required to reduce the probable error of the means, be $\pm0^{\circ}\cdot1$ C

$$n_1 = \frac{n}{2n-1} \times 100\,(1\cdot1955)^2\,V^2_t$$

$$e.g.\; n = 15 \qquad 20 \qquad 25 \qquad 30 \qquad \infty$$

$$n_1 = 73\cdot9\,V^2_t \quad 73\cdot3\,V^2_t \quad 72\cdot9\,V^2_t \quad 72\cdot7\,V^2_t \quad 71\cdot5\,V^2_t$$

Even when the stations are distant 100 or 200 kilometres apart, if they have similar situations and are nearly at the same level, we find for a winter month 18 or 33 years, and for a summer month 8 or 13 years requisite, respectively, to ensure an accuracy of $\pm0^{\circ}\cdot1$ in the mean values of the temperature differences.

If the stations lie close to each other, and the difference of level is about 500 metres, we find that in winter 29, in summer 7 years are necessary to insure a similar degree of accuracy. Even when the difference of level is 1,000 metres the number of years requisite is 63 and 11; and on the mean 22.

In respect of influence on the mean variability of temperature differences we find that 100 metres difference in vertical height is equivalent to a horizontal distance of 84 kilometres in winter, 16 kilometres in summer, and 22 kilometres on the mean of all the months.

If the problem is to determine in detail the conditions of temperature of a country, we see from the preceding remarks how the system of observation should be arranged in order to attain our aim as speedily and cheaply as possible. A number of principal stations are required at proper distances apart and at proper differences of level, and then a number of temporary stations should be established and their temperature differences, as compared with the principal stations, determined with more or less accuracy by five years' observations. These latter stations can then be moved to other points till the distribution of temperature over the whole country has been determined in detail.

The second question, as to what are the limits of horizontal distance or of differences of level for the application of this mode of reduction to means for long periods, is answered for the whole region of the Alps as follows:—

The mean variability of the monthly means is for the—

	Winter.	Summer.	Mean.
North and East Alps ...	2°·18	1°·15	1°·58
South Tyrol and North Italy	1°·56	1°·02	1°·25

This variability, by the preceding formulæ for temperature differences, will be reached for the *differences* of temperature at the following heights and following differences of level:—

	Distance in Kilometres.		
	Winter.	Summer.	Mean.
North and East Alps ...	1080	1050	990
South Tyrol and North Italy	690	890	740

	Differences of Level in Metres.		
	Winter.	Summer.	Mean.
North and East Alps ...	3000	6500	4600
South Tyrol and North Italy	2000	5600	3400

We therefore see that the reduction of mean temperatures for short periods to a long standard period does bring with it a certain definite advantage in all cases which practically come under the consideration of the meteorologist.

With the communication of these results I close the excerpt from my work, which I venture to lay before the Society, with the hope that it may act as an incentive to my colleagues to carry out similar investigations in their own countries, and possibly eventually lead to the speedy publication of really comparable and accordant temperature means for North America. The calculation of such means cannot be carried out by European meteorologists, for the simple reason that the results of the temperature observations in North America have never been fully published.

DISCUSSION.

Mr. STANLEY said that from personal observations it appeared to him that mountain temperatures increased most rapidly in the autumn. In September 1874, while sketching the Silberhorn (which was then covered with newly fallen snow) from the Wengern Alps, the water he was using was frozen at noon, whereas the temperature of the Grindelwald Valley below was high, 65°; in summer there was no such difference. He had made similar observations in other cases.

Mr. GASTER said that those who had experience in drawing isothermal charts for a lengthened period of years would know how difficult it is to correct the means for a short period so as to make them show the probable values which would be indicated by observations for a larger number of years. Mr. Buchan, in the construction of his Mean Isothermal Charts for the twenty-four years 1857 to 1880, had used some observations made during periods varying as small as two years, while others extended through the whole twenty-four years, and in order to use the observations for the shorter periods a correction had been applied, which approximately overcame the irregularities in the periods of observation; but these resulting isothermal charts were not so satisfactory as could be desired, the shorter period of observations being too numerous, and spoiling the results from the longer series. Mr. Gaster had redrawn one isothermal chart (for the month of January), using only the longer series of observations, and in consequence had obtained a distribution of temperature which he could not help thinking was more satisfactory. This is reproduced as fig. 2 (p. 38), from which it will be seen that the large cold area over Scotland and the North of England shown in Mr. Buchan's map (fig. 1, p. 38) is divided into two distinct parts by a band of relative warmth. This he thought was explained by the fact that the prevalent winds in the British Isles being Westerly, bring with them a certain proportion of warmth from the Ocean whence they are drawn, and meeting with no obstruction, they pass readily along the valleys of the Clyde and Forth, and make those regions relatively warm. Now if this is the case in winter, the opposite conditions should prevail in summer, and a rough chart, prepared in a similar manner for July, showed a cold band in the place of the warm one mentioned above. He referred only to the distribution of the isotherms over Scotland, because the information for England and Ireland was insufficient for the question to be properly tested there. He was working at this subject with the published results of the observations made at this Society's stations, and hoped before long to communicate a paper to the Society on the results of his investigations.

If, therefore, such care is necessary in "correcting" values derived from short periods of observations made at or near the sea level, how much more cautious must we be in applying similar corrections to observations made at levels with regard to which we know so little?

Mr SYMONS considered Dr. Hann's paper would be a very valuable addition to the *Quarterly Journal*, coming as it did from so eminent a meteorologist. He hoped that Mr. Gaster in constructing his charts would be careful about drawing isothermal lines across Wales, as there were only two or three stations all through that district, and the differences of elevation were very considerable.

Mr. C. HARDING remarked that Mr. Buchan had no doubt worked up his temperature observations in a similar way to Dr. Hann, but there was no evidence that he had tested the results by ascertaining the "probable error." He rather doubted whether, as stated in the paper, five years would give a sufficiently long period to obtain a reliable mean, but Dr. Hann had probably good reason for believing that five years were sufficient, guided by the "probable errors" which he had worked out with so vast an amount of labour.

THE PRESIDENT (Mr. Scott) said it was well known how difficult it was to get volunteer observers to stay at one place for any considerable time, and the results of Dr. Hann's paper seemed to show that this difficulty could be to some extent surmounted, as it was possible to obtain fairly correct averages, even from short series of observations, by the method given in the paper. This was particularly important for those who had the management of meteorological systems in the Colonies, where the stations were sparsely distributed and observers hard to find.

FIG. 1.

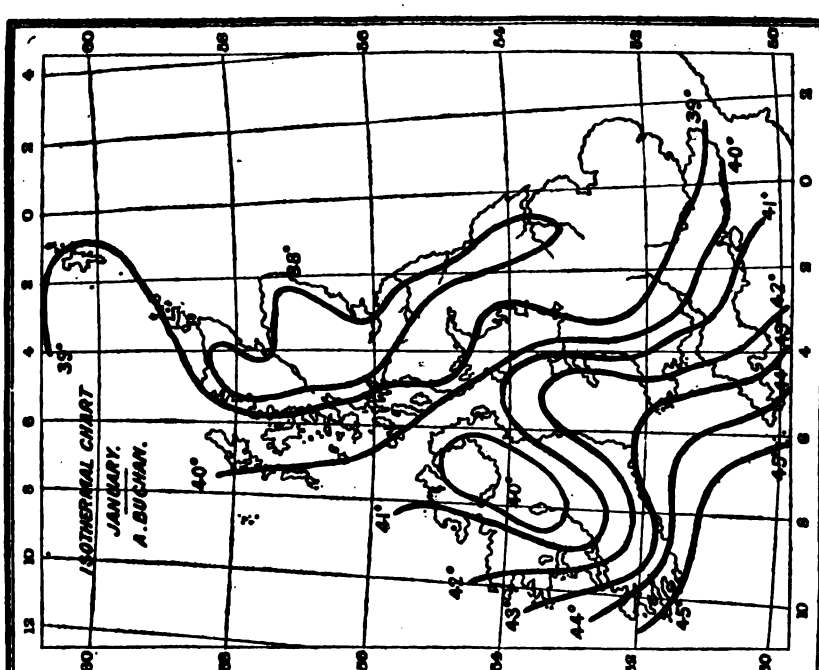
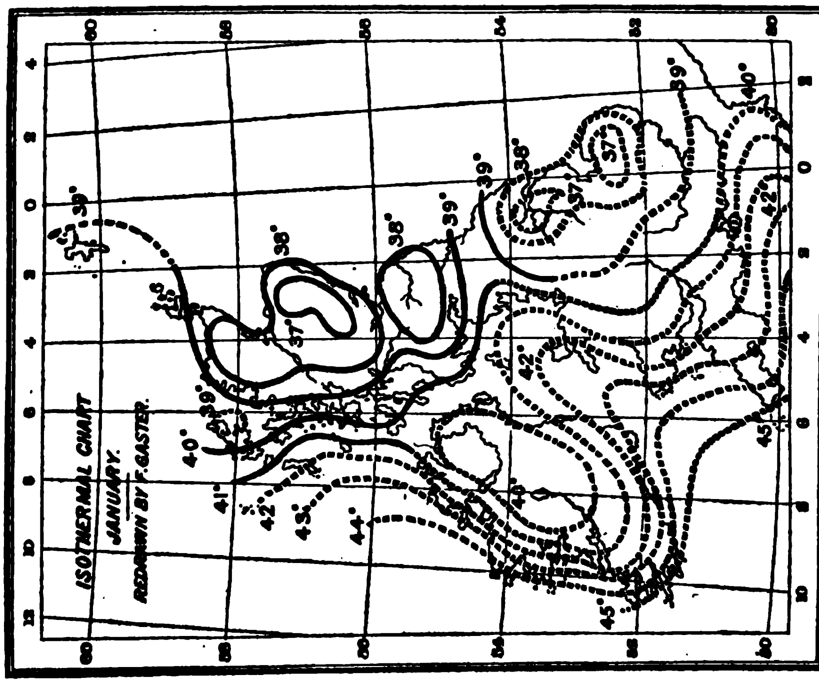


FIG. 2.



NOTE.—The isotherms over England and Ireland are drawn from insufficient information for their indications to be much relied on.

The Diversity of Scales for Registering the Force of Wind. By Charles Harding, F.R.Met.Soc.

[Read December 17th, 1884.]

At the present time, when so much precision is aimed at in the registration of Meteorological results, it is a matter for considerable surprise that more thought and attention have not been devoted to obtaining greater reliability in respect to wind observations. The whole system of registering wind force, whether instrumentally or otherwise, is one of very great confusion. It is with the view of calling attention to our present position with regard to this important observation, and, if possible, to show the absolute need of action for improvement, that I have been led to bring this much vexed question prominently before the Society. I do not lay claim to presenting any thing new, but from a somewhat intimate acquaintance with the various systems of registration followed by different countries, and an unmistakeable assurance of the confusion resulting from the want of uniformity of system, I am led to hope that a mere collation of some of the differences existing may prove both interesting and instructive, and may in some quarters at least tend to ultimate improvement.

Accustomed as most inquirers are to deal only with the observations of their own countries, or at the most to link with these the observations from other countries in a very general way, the real need for uniformity is likely to be overlooked, or if noticed, the inconvenience is borne with as inevitable. If mere inconvenience were the sole objection to the multiplicity and variability of wind scales, in the same way as Fahrenheit, Centigrade, and Reaumur scales for temperature are inconvenient, there would be little or no need for calling especial attention to the subject. It is, however, far different, for in many cases the scales most effectually baffle any attempt at comparison.

The United States International Bulletin, in which the wind scale is 0 to 10, gives various remarks which "relate to the individual peculiarities of the methods of recording the international simultaneous meteorological observations, under the auspices of the various meteorological bureaus." The following will show some of the "peculiarities" with regard to the scale of wind force for some of the countries co-operating in this admirable international work:—

Wind Scale.	Series of Observations.
0—4	Italian.
0—6	Danish.
	French.
	Norwegian.
	Scottish.
	Swedish.
0—7	Turkish (part).

Wind Scale.	Series of Observations.
0—10	German.
	Greek.
	Swiss.
	United States.
0—12	British.
	Turkish (part).

Other scales might be added to the above, such as for instance 0—9, which is used in the Paris *Bulletin International.*

Inconvenient as these different scales are, it would be of little importance if, when expressed in miles per hour, metres per second, lbs. per square foot, &c. the same relative proportion for the varying grades of the scale were kept up, but this unhappily is not even attempted by different observing centres in the same country, far less by the different countries, and the choice of the equivalents in miles per hour, lbs. per square foot, and so on, even for the Beaufort notation (0—12), for example, renders the fixing of a special unit of force in any meteorological discussion altogether hopeless, if anything like an approximation to certainty is desired.

It has already been mentioned that the scale used in the United States International Bulletin is 0 to 10; this emanates from the Signal Office of the War Department. The following gives a comparison of that wind scale, with the scale used by the Washington Hydrographic Office, the wind reports for which are by Beaufort notation, 0 to 12. For sake of comparison, the equivalents in miles per hour have been converted to the scale 0 to 10 :—

Wind Force.	U.S. Signal Office, miles per hour.	U.S. Hydrographic Office, miles per hour.
1 and 2	0 to 9	0 to 9
3 „ 4	9·1 to 22·5	9·1 to 18·2
5 „ 6	22·6 to 40·5	18·3 to 28·8
7 „ 8	40·6 to 67·5	28·9 to 69·6
9 „ 10	67·6 and upwards.	69·7 and upwards.

It will be seen that the widest differences occur with forces 6 and 7.

The following is the official rendering of Beaufort's Wind Force scale in England :—

FIGURES TO INDICATE THE FORCE OF THE WIND.

0 Calm		
1 Light air	Just sufficient to give steerage way	
2 Light breeze	With which a well-conditioned ship-of-war (of Admiral Beaufort's time (1800-1850),) with all sail set, would go in smooth water, and "clean full," from	1 to 2 knots
3 Gentle breeze		3 to 4 knots
4 Moderate breeze		5 to 6 knots

FIGURES TO INDICATE THE FORCE OF THE WIND—*Continued.*

			FOR SHIPS RIGGED WITH DOUBLE TOPSAILS.[1]
5 Fresh breeze	To which she could just carry in chase, "full and by"	Royals, &c.	
6 Strong breeze		Single-reefed topsails and topgallant sails	Topgallant sails
7 Moderate gale		Double reefed topsails, jib, &c.	Topsails, jib, &c.
8 Fresh gale		Triple reefed topsails, &c.	Reefed upper topsails and courses
9 Strong gale		Close-reefed topsails and courses	Lower topsails and courses
10 Whole gale	With which she could scarcely bear close-reefed main-top-sail and reefed foresail		Lower main-topsail and reefed foresail
11 Storm	Which would reduce her to storm-stay-sails		
12 Hurricane	Which no canvas could withstand		

The velocity of Wind in miles per hour for the respective units of scale are given in column (3) of table below.

1 These modifications are made to meet the requirements of double topsails, introduced since Admiral Beaufort's time.

The following table shows some of the diversities with regard to wind force:—

Beaufort's Scale.	Equivalent velocity of Wind in English miles per hour.					
	(1)	(2)[1]	(3)	(4)	(5)[2]	(6)[2]
0	—	—	3	—	—	—
1	7	—	8	2	1·5	1—2
2	14	5	13	3	2	4
3	21	10	18	5	4·5	9
4	28	18	23	7	8	14
5	35	25	28	12	12·5	17
6	42	33	34	15	18	20
7	49	40	40	22	24·5	24
8	57	55	48	31	32	30
9	64	63	56	37	40·5	40
10	71	70	65	43	50	67
11	78	78	75	57	61	80
12	85	85	90	68	72	100 and upwards.

1 These values are not copied, but are obtained by substitution from the figures given.
2 Probably the figures in cols. 5 and 6 are sea miles, in which case the numbers would require to be increased by about one-sixth.

The formula given by Sir H. James for the conversion of velocities into pressure in lbs. per square foot is $P = v^2 \times \cdot 005$.

Where v = velocity in English miles per hour.

Hitherto meteorologists have used the above formula irrespective of whether the miles were English or sea miles.

The authorities for the respective columns are:—

(1). Col. Sir H. James, R.E., *Instructions for taking Meteorological Observations*, Tables, p. 31. Published 1860.

(2). Admiral FitzRoy. *Weather Book*, p. 38. Published 1863.

(3). Meteorological Office. *Instructions in the Use of Meteorological Instruments*, p. 58. Published 1875.

(4). Dr. C. Jelinek. Austrian Instructions for Keeping Meteorological Observations, p. 68. Published 1869.

(5). Sir C. Wyville Thomson. *Voyage of the Challenger*, p. 161. Published 1877.

(6). Commodore Wyman, Washington Hydrographic Office. *Meteorological Log*, p. 7. Published 1878.

Professor Mohn of Norway also gives a scale in his "Grundzüge der Meteorologie," but it is a copy of that issued by the London Meteorological Office.

The United States Hydrographic Office gives the following rendering:—

Force of Wind, Nautical Scale.	Nautical Designation.	Sail that a full-rigged ship may carry, close-hauled by the wind; also her probable speed.	Sail that a full-rigged ship may carry, wind on quarter; also her probable speed.	Velocity of Wind in miles per hour.
0	Calm	All sail	All sail.	0
1	Light airs	All plain sail and stay-sails; smooth sea; 0·5 to 1 knot per hour	All plain sail & studding sails; smooth sea; 1 to 1·5 knots per hour	1 to 2
2	Light breezes	All plain sail and stay-sails; smooth sea; about 2 knots	All plain sail & studding sails; smooth sea, 2 to 3·5 knots	4
3	Gentle breezes	All plain sail and stay-sails; smooth sea; 3 to 4 knots	All plain sail & studding sails; smooth sea; 4 to 5 knots	9
4	Moderate breezes	All plain sail and stay-sails; 5 to 6 knots	All plain sail & studding sails; smooth sea; 6 to 7 knots	14
5	Stiff breezes	Courses, topsails, to'gallant sails and stay-sails; moderate sea; 6 to 7 knots	All plain sail & studding sails; moderate sea; 8 to 9 knots	17
6	Fresh breezes	Courses, single-reefed top-sails, to'gallant sails; moderate sea; 7 to 9 knots	Courses, top-sails, to'gallant sails, lower and topmast studding sails; moderate sea; 10 to 12 knots	20
7	Very fresh breezes	Courses; double-reefed top-sails, fore topmast stay-sail; moderate sea; about 7 knots	Courses, single-reefed top-sails, to'gallant sails; moderate sea; 12 to 14 knots	24
8	Moderate gale	Single-reefed courses, treble-reefed fore and main top-sails, close reefed, mizen, fore top-mast stay-sail; rough sea; 4 to 5 knots	Single-reefed courses; double-reefed fore and main top-sails, close-reefed mizen; rough sea; about 10 knots	30
9	Strong gale	Close-reefed courses, close-reefed fore and main top-sails; storm stay-sail; rough sea.	Close-reefed courses, close-reefed fore and main top-sails; storm stay-sails; rough sea.	40
10	Very strong gale	Close-reefed fore-sail, close-reefed main top-sail, fore storm stay-sail; very rough sea.	Close-reefed fore-sail, close-reefed main top-sail, fore storm stay-sail; very rough sea.	67
11	Violent gale	Storm-sails, or close-reefed main-top sail and fore storm stay-sail; very rough sea.	Close-reefed fore-sail, close-reefed main top-sail, fore storm stay-sail	80
12	Hurricane Typhoon Cyclone	None; lying to; drifting bodily to leeward	Scudding under bare poles	100 and upward

The above scale has been copied into the Swedish Meteorological Log.

The Logs of the Netherlands Meteorological Institute give a scale of 0—11 for use at sea.

The Danish Meteorological Institute gives a scale of "half Beaufort's figures" for use at sea.

The differences appear even greater when a comparison is made of the pressures in lbs. per square foot. For example: Beaufort's force 2, according to the values given in col. 1 of the preceding table (14 miles per hour) is equivalent to ·98 lb. per square foot; whilst the corresponding value in col. 5 (2 miles per hour) is only ·02 lb. per the square foot; so that one authority gives the pressure of the wind 49 times as great as the other. A similar comparison for force 3 gives the result by col. 1 as 2·2 lbs on the square foot, whilst by col. 5 it is only ·1 lb.: the one being 22 times as great as the other.

It would be useless to attempt to explain the cause of the great differences which exist, and with the present condition of anemometry, it does not seem possible that a uniform scale of equivalents could be agreed upon. Possibly much of the difference arises from the confusion which exists with regard to the proper factor to be used for the conversion of the space through which the cups of the anemometers travel, into actual velocity of the wind. I do not, however, intend in the present paper to dwell upon this point; but it is now generally agreed that the factor varies according to the size of the hemispherical cups, and besides this, the gearing and other details in the make of the instrument have an important bearing upon the relation between the speed, as shown by the anemometer, and that actually possessed by the wind.

Although the Beaufort notation, 0 to 12, is generally adopted by the different Meteorological bureaus for the registration of wind force at sea, there exists in the scale itself so much uncertainty owing to the standard of comparison, Beaufort's "Ship of War," being to sailors of the present generation so very indefinite, that widely different opinions must exist with respect to any special unit of the scale. The rig of the vessel must also have an important bearing on the result, and to a steamship the whole argument of the scale is cut adrift; but here the observers' experience doubtless finds a very good substitute.

The proportion of vessels, however, even in the British Mercantile Marine, in which the Beaufort notation is used, is exceedingly small compared to the whole number afloat. The system adopted by sailors of all nationalities, is to record the wind in such general terms as "light," "moderate," "brisk," "fresh," "strong," "gale," "storm," &c.

There are many varying circumstances besides what might fairly be termed personal error, a quantity in itself of no small importance, which influence the logging of the wind force on board a ship; among these may be mentioned the ship's course in relation to the wind direction—the tendency being to overrate when beating, and to underrate when sailing free. Temper and expectation have their important bearing; for instance, it is quite common to find the wind force noted as light in the Trades, when it must at least have been moderate, the reason being evidently that a Trade of stronger force was desired.

Surely, with the many instruments which now exist for the exact observation of various meteorological elements, such as atmospheric pressure, temperature,

specific gravity of sea water, &c. it is time that a determined effort should be made for the production of a simple instrument to measure the force of the wind, and one which might be universally adopted. With a small anemometer, for which the proper factors could be determined, much valuable work could be done, and standard scientific results produced.

On land there are so many elements of uncertainty introduced, such as the effect of the proximity of buildings, trees, and even shrubs, the varying temperature of the ground due to the diurnal influence of the sun's rays or even to the peculiarity of the soil, that the greatest care is necessary in making observations. Difficulties almost equal to these have to be grappled with on board ship, for there we have the draught from the sails, and a cushion caused by the wind striking against the hull of the vessel and being forced upwards; yet on the whole it seems that far more satisfactory results might be obtained at sea than on shore. Probably the best results could be obtained from a steamship, by a selection of a part of the vessel as free as possible from interfering causes.

It seems now one of the most important steps in Meteorology to secure a simple and inexpensive anemometer; and for the determination of the factor, whatever form the instrument may take, I would urge the desirability of experiments being conducted on our railway locomotives and on steam vessels, in preference to a merry-go-round, since in the case of the latter, one can quite conceive it possible for a motion to be set up in the adjacent air prejudicial to the results. If a standard form of instrument could be decided on, it ought to be a simple matter, with the cooperation of a few observers experienced in registering wind force, to determine the relative equivalents in miles per hour, or in lbs. per square foot, &c. for any numerical scale agreed upon.

The Beaufort notation, being the most extended scale of those in use, should perhaps for this reason alone have preference given to it, since the scale is sufficiently open to admit of all forces being registered by one of its units, without recourse to decimal parts of the scale, and at the same time its several units represent a sufficiently distinct force to allow of the right figure being used to represent any strength. Without mechanical assistance, however, Beaufort's scale used ashore is merely a scale of estimation divided into 12 grades, 1 being a light air and 12 a hurricane.

The fact that the United States Signal Service has already adopted 0—10 as the scale for use in its international series of observations is certainly an argument, which should not be overlooked, in favour of the general adoption of the scale 0—10, and the points mentioned above in support of the adoption of Beaufort's scale, 0—12, can be here similarly applied, since the limits of the two scales differ but slightly. To illustrate the necessity for a better understanding on the above head, I shall refer to the *Report of the Committee appointed to inquire into the Loss of H.M.S. Atalanta*. At p. 182 we find the following:—Question 4894. "What would be the pressure of wind per square foot necessary to capsize the *Atalanta*, coming in the form of gusts, in her various conditions? ANS.; "If you suppose her with all plain sail

set in the upright condition, a gust of 6½ lbs. to the square foot of canvas would be sufficient to blow her over. That is, supposing the ports to be closed, and the vessel to be in the loaded condition. With the ports open it would be 8·2 lbs. per square foot."

Without attempting to say whether or not this reply was correct, I would suggest that meteorologists are not in a position to answer what appears so simple a question. By reference to the tables published by the Meteorological Office (as well as by several other authorities) we find that a pressure of 8 lbs. on the square foot is represented by a moderate gale (force 7 of Beaufort); whereas by reference to the table published by Sir C. Wyville Thomson in the *Voyage of the Challenger* (as well as by several other authorities) we find that a pressure of 2·8lbs. represents a moderate gale. With such diversity of opinion, I would ask how is it possible for a Commander to estimate the pressure on his sails?

DISCUSSION.

Capt. TOYNBEE (who was unavoidably absent from the meeting) said in a letter, which was read by the Secretary:—This is a valuable paper, since it brings to the notice of the Society the various irregularities which exist in estimating the force, speed and pressure of wind. It is time that meteorologists of all countries should agree on the subject, which is, I think, worthy of international consideration.

The anemometer question has many difficulties. Suppose, for instance, that a perfect anemometer had been invented, can a perfect position be found for it? Will it not be subjected to eddies of all kinds? And will not a careful observer give a better estimate of the direction and force of the wind by watching the motion of lower clouds, the tops of seas, smoke, &c. than can be obtained from an anemometer? On board ship other difficulties arise, such as the course and speed of the ship, eddies from her hull, rigging and sails, which make it very improbable that anemometers will come into use at sea. Of course anemometers are needed for continuous records, and no pains should be spared to make them as perfect as possible; but it seems to me that the value of those records would be much increased if independent eye observations were made at certain hours of the day at each station by a careful observer. By this method a local error might be worked out for each anemometer both as to direction and force.

It seems, then, pretty clear that for the best observation of the wind at stated hours meteorologists must look to other means than to anemometers, and I believe we have those means in Beaufort's scale. In working up the data of the North Atlantic which are now being discussed by the Meteorological Office, I have been struck by the remarkable agreement, in estimating the direction and force of wind, amongst several steamers and sailing ships when near the same spot.

It might be well to make Beaufort's scale the subject of international consideration, more especially with regard to the meaning of the words which explain each figure. On glancing down the twelve lines of explanation I only find two which seem to my mind unnecessary, viz. *Force* 3, which is called "gentle breeze," a term which does not differ decidedly from Force 2, "light breeze." Again, *Force* 9, "strong gale," does not seem to differ decidedly from "whole gale," which is force 10. In all other cases the words express to the mind a decided difference in the force of the wind—a difference which it appears that landsmen as well as seamen easily grasp—so that Beaufort's scale, which is in use on the shores and ships of so many countries, might be translated as perfectly as possible into other languages, and adopted as a standard for universal usage until the difficulties which surround anemometers are removed.

I have been struck by the agreement in the observations by landsmen around our coasts which are telegraphed daily to the Meteorological Office, and have no doubt that most, if not all, the observers are guided by the explanatory words, and not by the amount of sail which neighbouring ships were carrying. A ship's sails

are an additional guide to seamen, both as to direction and force, which helps to make up for what they lose, by their observatory being itself in motion.

To sum up these remarks in a few words, they are intended to express the opinion that in spite of failure in anemometers, we have in the eyes and brains of ordinary men the most correct and simplest means for getting the direction and force of the wind, and that, up to the present time, Beaufort's scale is the best means devised for expressing those facts.

To render eye observations more complete, I would ask observers at land stations to record the direction from which really low clouds or high smoke are moving, and their apparent speed. I am in the habit of using the following scale for recording lower cloud speed:—0 = Stationary, 1 = Slow, 2 = Moderate, 3 = Fast. If thought requisite the 3 might be dotted or underlined to represent very fast.

Mr. Black said that he had invented an anemometer, and had had it placed on a man-of-war in order to test its working. He had tried it himself on several occasions, and found it worked well. The greatest pressure it had registered was during a South-west gale at Southport, the instrument indicating a pressure of from 6 to 8 lbs. He thought that it was very seldom that pressures of more than this amount were experienced in ordinary weather at sea. It was very desirable that experiments should be made to ascertain the most perfect position for the exposure of an anemometer on board ship, as it was quite possible to obtain greatly varying pressures in different parts of a ship. With respect to the Beaufort scale, he knew that as a rule captains were very accurate in their estimation of wind force by this method, and they could tell the amount of wind very exactly by watching the sea or putting out a hand to the wind. He did not see why, if this were possible to sea captains, landsmen should not, by means of personal observation, estimate the force of wind quite as accurately. With regard to the registration of wind force by means of instruments, it seemed that the whole question was in a most unsatisfactory condition. Mr. Black then read some particulars respecting the experiments on wind pressure which had been carried on at the Forth Bridge Works. He also asked if the six scales of wind forces alluded to by Mr. Harding could not be lumped together, and means drawn out of the whole set to make one authorised scale for general use.

Mr. Munro said that in comparing the results of the Forth bridge experiments on wind pressure, the weight of the different pressure boards used should be taken into consideration, as he thought that the differences in their weight would help to explain the differences between the pressures recorded by the different boards.

Mr. Laughton thought that the inequality of pressure in different streams of wind had more to do with the differences than the weight of the receiving-plates, which must be supposed to vary as to their area. From this point of view, small plates necessarily give a very incorrect idea of pressure. For instance, the anemometer at Greenwich, during the storm of October 14th, 1881, registered a pressure of 53 lbs. on a square foot. Now if 6 lbs. pressure is, as was stated, sufficient to overturn such a ship as the *Atalanta*, what would 53 lbs. do? The estimation of wind force depends on the judgment of the observer, according to some such scale as that pointed out by Captain Toynbee, but the transferring it to a scale of miles or pounds is a thing which cannot yet be done in any satisfactory manner. The more he thought of this subject of exact anemometry, the more hopeless did it seem.

Mr. Curtis thought the differences exhibited in the table between the figures in the first group of three columns and those in the second group, were due to the fact that they were based upon results derived from large and small anemometers respectively, between which it was perfectly well known that no safe comparison could be made, at any rate with our present knowledge, or want of knowledge, on the subject of anemometry. With regard to the use of anemometers at sea, he thought the difficulties in the way were really insuperable. The fact of their being carried upon a moving platform at varying rates and at different angles to the direction of the wind, was a preliminary objection; but in addition the influence upon the wind current of the hull of the ship, and the draughts of the sails, would so complicate the matter that the result would be very unreliable. On land, the problem of proper anemometer exposure was difficult enough, although it had probably been to some extent exaggerated, more

particularly as regarded the upward deflection of the air; but at sea the difficulties to be met were vastly greater.

Mr. WHIPPLE was astonished at the differences exhibited in Mr. Harding's table of velocities, and thought that the subject ought to be settled by an International Conference. He had no idea that there were so many diversities of scales existing. He should very much like to know on what authority Sir Wyville Thomson, in his work, *The Voyage of the Challenger*, Vol. I. p. 161, had given a scale of velocities differing so widely from those in general use in this country. With respect to the differences existing between the records of similar patterns of anemometers, Mr. C. E. Peek had constructed a *fac simile* of the Kew standard anemometer, and it was proposed to run the two anemometers side by side at the Kew Observatory for some considerable time. From this comparison he hoped that some interesting and valuable results would be obtained. He especially drew the attention of observers to the necessity of sharply looking after the lubrication of anemometers, as the clogging of the instruments was a frequent source of erroneous indications.

The PRESIDENT (Mr. Scott) remarked that Dr. Robinson, when testing his anemometer on a railway train, found that it was necessary to hold the anemometer at a distance of ten feet from the train in order to have it free from the influence of the current caused by the passage of the train. The merry-go-round experiments at the Crystal Palace were perhaps the most satisfactory, as the instrument was pretty free from eddies; they were, at any rate, better than those conducted at Hamburg and St. Petersburg, as the instruments at both these places were in a confined enclosure. With respect to Dr. Black's remarks, he said that the Beaufort scale was generally adopted by observers in this country, but there was a difficulty in using it, because of there being no definite standard. A captain had not only his personal sensations to guide him in his estimation of wind force, but he could judge fairly well the strength of the wind by watching its effect on the sea. The anemometer used by Sir C. Wyville Thomson during the voyage of H.M.S. *Challenger* was one of the small instruments supplied by the Meteorological Office, and these always registered too small a velocity.

Mr. C. HARDING, in reply, said that the Beaufort scale was practically based upon the amount of pressure that sails would bear, but he could not ascertain how this amount was determined. He, like Mr. Whipple, was astonished when he discovered the differences existing among the wind scales in use. With respect to Mr. Black's remark that a pressure of 8 lbs. on the square foot is rarely exceeded at sea, this was true according to Sir C. W. Thomson's scale, and also that of the U. S. Hydrographic Office, but was certainly not correct if Mr. Scott's values were used. He remarked that in his opinion the most reliable values were those given by Mr. Scott, and published in the *Instructions in the Use of Meteorological Instruments*. Mr. Dines, who was unable to be present at the meeting, had written to him to the effect that in the last three years the greatest weight he had seen blown over at Walton-on-Thames was 12¾ lbs. to the superficial foot; this was in January 1884. The method of testing the force on this occasion proved that the wind did not attain 16 lbs. to the square foot. Mr. Dines also expressed strong doubts as to the great pressure which the wind in some instances is said to have exerted.

REPORT ON THE PHENOLOGICAL OBSERVATIONS FOR 1884. By THE REV. THOMAS ARTHUR PRESTON, M.A., F.R.Met.Soc.

[Read December 17th, 1884.]

THE Returns sent in have been as a rule very satisfactory. Of course there are some doubtful dates, but they are comparatively few. It is unfortunate that so few of the present staff of observers were amongst those who began observing ten years ago; the original band has greatly diminished, and but three now remain. The changes in the staff have been considerable, but,

fortunately, mainly amongst those who recently joined. The observer at Great Cotes has now ceased; his returns were very important, as he had sent in returns for nine years, but other business has prevented his sending any this year.

The following is the list of observers:—

Addington	Buckinghamshire	J. Mathison.
Babbacombe	Devon	E. E. Glyde.
Belton	Lincolnshire	Miss F. Woolward.
Bocking	Essex	A. S. Tabor.
Braintree	Essex	H. J. Cunnington.
Bristol	Gloucestershire	Miss Hester Coles, and Miss E. Francklyn.
Buildwas	Shropshire	Rev. H. L. Graham.
Cardington	Bedfordshire	J. McLaren.
Carlisle	Cumberland	T. Hands.
Croxley	Herts.	S. G. Lloyd.
Croydon	Surrey	W. H. Miller.
Cushendun	Co. Antrim	Rev. S. A. Brenan.
Downside	Somerset	H. Mostyn.
Geldeston	Norfolk	Miss S. S. Dowson.
Guernsey	Channel Islands	Miss M. Dawber.
Hampson	Lancashire	Miss M. Johnson.
Harpenden	Herts.	J. J. Willis.
Hassocks	Sussex	C. Needham.
Hatton	Lincolnshire	Mrs. Jarvis.
Hertford	Herts.	R. T. Andrews.
Hodsock	Nottinghamshire	Miss A. Mellish.
Killarney	Co. Kerry	Rev. G. R. Wynne, M.A.
Macclesfield	Cheshire	John Dale.
Maresfield	Sussex	Mrs. Green.
Marlborough	Wilts	Rev. T. A. Preston, M.A.
Northampton	Northamptonshire	H. N. Dixon.
Oxford	Oxfordshire	F. A. Bellamy.
Parbold	Lancashire	Mrs. Coombs.
Royston	Herts.	A. Kingston.
St. Michael's-on-Wyre	Lancashire	Miss S. Hornby.
Salisbury	Wilts.	W. Hussey.
Sawbridgeworth	Herts.	Miss Simpson.
Strathfield Turgiss	Hants.	Rev. C. H. Griffith.
Streatham	Surrey	C. U. Tripp, M.A.
Tacolneston	Norfolk	Miss E. Barrow.
Tidenham	Gloucestershire	Miss K. Evans.
Tiverton	Devon	Miss M. E. Gill.
Trowbridge	Wilts.	Mrs. Gregory.
Ware	Herts.	Lieut. R. B. Croft.
Watford	Herts.	J. Hopkinson.

Wellington College	Berkshire	S. A. Saunder.
Wells	Somerset	The Misses Livett.
Westward Ho	Devon	H. A. Evans.
Wickham	Essex	H. N. Dixon.
Wicklow	Co. Wicklow	The Misses Wynne.
Wincanton	Somerset	A. G. Shaw, and W. Galpin.
Woolaston	Gloucestershire	Miss C. J. Purchas.
Yeovil	Somersetshire	Rev. J. Sowerby.

The salient features of the past year in England have been—(1) the mild winter; (2) the very cold April; (3) the very hot August; and (4) the long period of drought, which at the end of September began to be seriously felt. The general effects on vegetation have been—(1) the very prolonged existence of many of the autumn species, causing much confusion in the spring months, as the old plants were not killed down by the time the new plants came into flower, and among these plants the dates of flowering are very confusing; (2) the great loss of wall fruits: pears also suffered much, and apples in some localities, although the apple crop has been most abundant in others; (3) bush fruits generally a failure; (4) strawberries very plentiful as long as they lasted, but the time was short; (5) hay good in quality, but light in quantity, and very well harvested; (6) a generally good corn crop; (7) an unusually plentiful potato crop; and (8) great abundance of wild fruits, hips, haws, and especially blackberries.

I have again to express my best thanks to Mr. W. F. Miller for the trouble he has taken in analysing the Sheets of Returns, and thus rendering an essential service.

The Stations have as usual been grouped into districts—(1) those in the South-west of England; (2) those South of the Thames; (3) Central England —Oxford, Addington, Cardington and Northampton; (4) the Hertfordshire group; (5) those in the East of England—Wickham and Bocking in Essex, Geldeston, Belton, and Tacolneston in Norfolk, and Hatton in Lincolnshire; (6) the Northern group—Hodsock, Macclesfield, Hampson, St. Michael's-on-Wyre and Carlisle; (7) Ireland; and (8) Guernsey.

The observer in Guernsey began this year; the specimens sent were most luxuriant, and hence some errors may have occurred; no doubt in future years these will be corrected, for it is evident that it will be a very interesting Station.

An examination of the Table giving the average date in each group will show that group (2) (South of the Thames) was the earliest in the two first months; in the two next there was a considerable degree of variation, doubtless owing to the fact mentioned above, viz. that true "first flowering" was very difficult to decide; and that in the next two months group (2) again was the earliest. Group (1) is very variable, and rarely is the most forward; a more careful examination of the climate of the different stations may reveal some cause of this; any how, Babbacombe again, as in former years, enjoys the reputation of being remarkably late.

To turn now to the General Report—

The last three months of 1883 were, as a rule, very mild; occasionally, however, a sharp frost occurred, but in no case were frosts so severe as is usually experienced at that time of year.

October began cold, and this may have hastened the turn of the leaf; seldom have the autumn tints been so magnificent, and in consequence of the very light winds (often dropping to a calm for some hours) the leaves remained on the trees for a long time, and the country was extremely beautiful for weeks.

At the end of the month, at Salisbury, "foliage was still very plentiful, Beeches were in all their autumnal glory, and during the last ten days the Elms began to turn yellow and the Oaks were dull green." Wild fruits were scarce; no Sloes, Holly Berries or Beech Mast, and Acorns far from plentiful. Primroses and Barren Strawberry were in flower in the South of England, and wild flowers were generally abundant. At Tiverton 148 wild flowers were seen, at Croydon 179, and at Marlborough 268 during the first week, but only seventy during the last.

The last Swallow was seen at Hatton in Lincolnshire on October 8th, but at Salisbury the last of the Swallow tribe did not disappear until October 21st.

The first three weeks of November were rather colder than usual, but the last week was warm. A sharp frost occurred on the 7th, and though the temperature near London fell to 24° on the grass, yet at Lewisham Dahlias, Tropæolums and other tender plants were unaffected by it; the same thing happened in other parts of England; but in some few places, especially near water, the French Beans were slightly touched. Dahlias were gathered at Hatton on the 8th, but were destroyed on the 12th; at Wells a wild Rose (*R. canina*) was gathered on the 6th; at Worthing a specimen of the early Purple Orchis (*O. maculata*) was found in coloured bud; and at Tiverton the Foxglove was still in flower on the 29th.

At Croydon 108 wild flowers were found, as against 142 in 1882, though 99 garden ones were exhibited, as against only 58 in 1882; at Tiverton there were 125, and at Marlborough only 70; whilst at Downside, near Bath, there were very few flowers, owing to the heavy rainfall, but Hips and Haws were extraordinarily common.

At Salisbury a gale visited the neighbourhood on the 17th, which swept off a good deal of the foliage, and trees were bare by the end of the month. At Worthing foliage was very dense as late as the 23rd; at Downside the Horse Chestnut, Lime, and Wych Elm were defoliated during the first week; the Elm, Oak and Ash during the second week, "the leaves being frozen and therefore kept on the trees," and the Beech by the middle of the month; and at Northampton the Elm was bare by the 14th, but the Oak not till December 6th. At Marlborough the Mulberry was defoliated on the 18th.

The weather during December was unusually mild, and wild flowers might have been expected in more than ordinary numbers; but with the exception of a few, to be noticed presently, there were very few spring flowers, probably owing to the want of sun, for the month was extremely foggy and damp, but

not wet. Hazel was decidedly earlier than usual, two catkins with immature anthers being found at Salisbury on the 31st; it was in flower at Croydon on the 23rd, and "well out" at Cardiff on the 20th. Mercury was plentiful at Croydon on the 16th; and fertile flowers were found at Cardiff on the 20th. *Veronica hederifolia*, *Cardamine hirsuta*, and a species of *Salix* in flower and leaf, were found at Croydon; and *Draba verna* at Yeovil. But though spring flowers were so scarce, the survivals from the summer were fairly abundant, and some species have not, as far as I am aware, been noticed in December before. (*Papaver Argemone*, *Vicia Sepium*, *Poterium Sanguisorba*, *Ballota nigra*, and *Polygonum aviculare* were found at Croydon.)

At Tiverton seventy-three species were found, twenty, at Geldeston, and thirty-nine at Yeovil, as against sixty-eight in 1881 and 48 in 1882.

Fieldfares were seen at Wincanton on the 6th; Redwings in large flocks at Downside early in the month, and Woodcocks at Hatton on the 13th.

January was an extremely mild month, but with very little sunshine (at Wells it was "remarkably damp and dull, and at Downside there were heavy rains during a good part of the month; " but the weather on the whole was favourable for flowers.") This want of sunshine is the reason given by many observers (and very probably the correct one) why spring flowers have not been so forward as might have been expected. As a proof of this, not a single plant has been recorded as in flower at all of the Stations from which returns have been sent; even the Snowdrop was not found at Maresfield until February 3rd, and at Wells not till February 8th. The Hazel and Dogs' Mercury were in flower, but at some places the Pilewort was very late. At Killarney the Milkwort was in flower, and the Horse Chestnut with leaves quite two inches long. At Babbacombe vegetation was reported to be forward, and at Strathfield Turgiss, " about two-thirds of the plants which usually are recorded as flowering in February, March and even April, are now (February 11th) in full flower, and have been so all the winter, *e.g.* Primroses were abundant by November 19th, 1883, and Hazel, Pilewort, &c. all in full flower before Christmas." This, however, is quite exceptional. At Salisbury, on the other hand, "*Petasites* was above ground, but not in flower; Rooks pairing, but no nests; no Bees about; no Larks singing, and no Frogs' Spawn." Plants at Marlborough were about eighteen days early.

The survivals from the autumn were still numerous, and in some places were very remarkable. Bush Vetch, Greater Stitchwort, Bramble, Ivy, Holly, Broom, Teasel, Water Cress, Water Betony (*Scrophularia*) and Germander Speedwell were found, as well as the less uncommon Ox-eye, Corn Marigold, Herb Robert, and Centaury. At Hodsock thirty-six species (cultivated and wild) were found; at Marlborough thirty-two wild, Croydon forty-five, Tiverton fifty-one, Wickham (Essex) sixty-five, and Cardiff as many as eighty-seven. At Croydon, Mr. Mawley writes:—" One or more rose blooms were always to be had; a number of Geraniums at the South edge of a small shrubbery were, at the end of the month, still alive, and retained quite one-fourth of their foliage, while several bedding Calceolarias, growing in an

exposed border, appeared at the same time in as vigorous and healthy a condition as the autumn left them. The three facts I have just mentioned are, in my experience, altogether unprecedented."

Wheat and Oat crops were strong and healthy, with dark green foliage.

A Wood Pigeon's nest with eggs newly hatched out was found at Wicklow during the last week of the month, and a Sparrow's nest with one egg on January 5th at St. Michael's-on-Wyre.

February was, on the whole, a mild and dry month, with only a moderate amount of sunshine, and but very few frosts. In the South-west of the country it was different; at Wells April weather was experienced, and at Downside it was "ill-suited to vegetation, there being cold winds and great quantities of rain;" whereas in Norfolk it was "the driest February for the last twenty years," in the Eastern counties generally "vegetation was very forward;" but the flowering of plants over England, as deduced from the records sent in, was very capricious, the South-west of England generally being latest, sometimes later than Carlisle.

A careful comparison of the dates of flowering this year with those of the previous ten years at Yeovil shows that, as a rule, plants were later (often much later) than last year, but earlier than the year before, and much earlier than in any previous year, except 1877, and partially so in 1878. A similar comparison of the dates at Marlborough this year with those of the previous nineteen years shows that in about half the number of instances they were earlier than those of any previous year but later in the others than those of 1882 or 1883, though earlier than those of the previous seventeen years. The more remarkable exceptions are *Ficaria*, *Tussilago*, *Taxus*, *Draba*, *Viola odorata*, *Salix caprea*, and the main flowering of *Caltha*. As these plants grow some in dry and others in wet places, and include trees, shrubs and herbs, it is difficult to suggest any reason for this extraordinary variation. Plants were, on the whole, twenty-nine days earlier than the average of the previous nineteen years (at Marlborough). Old plants still hung on, as many as 113 (old and new) having been observed in some part or other of England during the month; fifty-one were observed at Tiverton, fifty-three at Northampton, sixty-three at Yeovil, and seventy-one at Findon, near Worthing.

At Marlborough some plants were very slow in coming into flower, the most noteworthy being the Scarlet Ribes; this was found with an open flower or two on February 23rd, but on March 14th there was not a single Raceme in full flower, in fact it was over three weeks before it was tolerably in bloom.

At Croydon "Pastures were fresh and green, while all kinds of fodder were unusually plentiful. In the market and other gardens the supply of vegetables has seldom, at this period of the year, been known to be so good and abundant." The Calceolarias mentioned in January still remained uninjured, but the Geraniums, though alive, suffered by the frosts of the last three nights.

The first and last weeks of March were cold, not unusually so for the time of year, but the middle fortnight was unprecedentedly warm. The first few days were damp, but the remainder of the month was dry, and there was very little sunshine. Vegetation on the whole, though still forward, was

rapidly sinking to its normal state The average date of flowering in January was eighteen days before the mean, in February twenty-nine, but in March only nine, and if wild plants alone be considered, only four; still at the end of the month the average was about thirteen days early. This difference was caused by the extraordinary behaviour of some plants, which were actually behind their usual time; the more noteworthy in this respect were the Sweet Violet, Marsh Marigold, Sallow, Dog and Hairy Violet. Some plants again seem to have been an unusual time in coming to their full flowering stage. Thus, at Salisbury, the Pilewort was no less than five weeks ere it was generally out, Cuckoo Flower and Greater Stitchwort were also very long in opening a second specimen: the Blackthorn, again, is generally noticed as being extremely partial, some bushes being perfectly white with bloom, whilst in other localities the buds were scarcely bursting.[1] At Wells the Coltsfoot was nearly a month later than last year. At Tacolneston a Horse Chestnut, which was very far advanced, remained almost in the same state during the last week of the month. A similar occurrence was noticed at Downside. At Yeovil, "of the thirty-two plants observed in January and February, twenty-six were still in flower (at the end of March), and twenty-nine of the fifty which were in bloom at the end of the year, some of them being much more common, though it was hardly possible to make 'first notices' of them." During the first fortnight only one plant (the Daffodil) came into flower, eleven in the next seven days, and thirty in the last ten. *Primula veris* at the same spot as last year was seventeen days late, caused probably by the drier weather of this year. In Guernsey the survivals were curious—Ragwort, Devil's-bit-Scabious, Mouse-ear Hawkweed, and Self-heal were all found as late as February 21st.

At Harpenden, Wheat plants and winter Oats were looking remarkably well at the end of the month.

The warm days in the middle of the month brought out insects, and Brimstone and White Butterflies, as well as small Tortoise-shells, were seen in many places. At Croydon Aphides made their appearance on roses about the 18th, and as the month advanced the under sides of the leaves were covered with them.

The Horse Chestnut, which was in leaf in January in Guernsey and at Killarney, was in leaf in the South of England about the 15th, at Streatham and Braintree on the 22nd, and at Bath and Hampson on the 31st. It was not recorded as in leaf at Macclesfield till May 12th.

The first week of April was fairly warm, but it then turned very cold, with severe frosts at night. Fortunately it was very dry, so that vegetation as a whole was only much retarded, and by the end of the month was not so far advanced as usual. The warm winter had, however, brought on some things, and the damage to the fruit blossoms was very serious. Cherries, Pears, Plums, and Gooseberries, are especially mentioned as having suffered

[1] At Addington some bushes were in flower on the 19th; but some were still in bud as late as the 30th.

TABLE I.—AVERAGE DATE (DAY OF YEAR) OF FIRST FLOWERING IN EACH GROUP, 1884.

No. and Name of Plant.	South-West of England.	South of Thames.	Central District.	Hertfordshire.	East of England.	North of England.	Ireland.	Guernsey.
78. *Galanthus nivalis*	22	14	15	19	13	17	13	..
74. *Corylus Avellana*	21	9	17	13	28	32	26	..
2. RANUNCULUS FICARIA	18	30	31	39	37	41	17	..
70. *Mercurialis perennis*	25	22	28	31	27	31	..	..
45. TUSSILAGO FARFARA	53	44	52	49	51	53	59	54
44. *Petasites vulgaris*	51	30	..	67	67	80	..	..
10. *Viola odorata*	41	43	43	..	59	55	34	..
72. *Salix caprea*	54	62	61	69	66	64	55	..
77. *NarcissusPseudo-narcissus*	56	50	60	63	..	70	45	44
71. *Ulmus montana*	50	52	47	48	48	48	34	(62)
9. *Draba verna*	43	62	(26)	60	(38)	(82)	8	..
1. ANEMONE NEMOROSA	65	66	74	66	77	76	74	..
4. CALTHA PALUSTRIS	65	70	72	90	69	85	86	..
64. *Nepeta Glechoma*	73	74	80	78	81	96	81	80
27. PRUNUS SPINOSA	74	74	75	73	78	88	(64)	69
68. PRIMULA VERIS	79	81	78	79	82	107	..	..
7. *Cardamine pratensis*	94	91	88	97	96	102	104	92
13. *Stellaria Holostea*	76	86	105	86	89	96	93	..
79. SCILLA NUTANS	84	91	107	99	103	108	91	80
60. *Veronica Chamædrys*	99	97	97	116	103	128	98	52
69. *Plantago lanceolata*	98	102	103	114	113	117	122	92
8. *Sisymbrium Alliaria*	101	101	102	99	101	117	105	115
39. *Syringa vulgaris*	123	121	125	123	125	128	119	111
3. *Ranunculus acris*	125	107	112	109	120	121	136	61
32. *Cratægus Oxyacantha*	125	128	120	124	124	133	122	111
25. *Vicia sepium*	128	117	120	121	120	135	117	117
20. *Æsculus Hippocastaneum*	133	129	136	128	138	137	99	111
58. *Symphytum officinale*	134	128	126	127	146	141	124	(177)
21. *Cytisus Laburnum*	134	138	135	136	137	136	124	113
31. *Pyrus Aucuparia*	136	127	133	133	130	140	118	129
11. *Polygala vulgaris*	137	124	131	145	149	132	136	(52)
67. *Ajuga reptans*	122	114	116	126	113	128	112	112
17. GERANIUM ROBERTIANUM	95	113	127	112	122	140	109	(46)
19. *Acer Pseudo-platanus*	136	121	110	102	122	123	100	..
59. *Pedicularis sylvatica*	117	116	123	117	..	137	112	105
73. *Fagus sylvatica*	137	132	..	140	131	136	132	..
40. *Galium Aparine*	138	133	138	137	134	148	114	142
18. *Euonymus europæus*	143	148	145	140	143	154	146	..
22. TRIFOLIUM REPENS	145	144	140	142	147	155	145	108
29. *Potentilla anserina*	139	143	141	143	148	156	140	147
23. *Lotus corniculatus*	138	139	149	143	147	141	128	110
47. *Chrysanthemum Leucanth.*	135	139	136	138	143	157	149	110
54. *Hieracium Pilosella*	140	143	143	145	158	150	136	..
6. *Nasturtium officinale*	145	155	150	149	145	162	140	153
12. *Lychnis Flos-cuculi*	147	145	143	144	147	165	146	108
26. *Lathyrus pratensis*	158	155	167	153	161	169	168	..
5. *Papaver Rhœas*	157	152	156	142	151	158	166	154
46. ACHILLEA MILLEFOLIUM	178	175	179	178	177	184	179	174
76. *Iris Pseud-acorus*	147	156	157	160	155	165	148	126
75. *Orchis maculata*	157	149	154	151	159	161	156	138
30. *Rosa canina*	155	157	159	155	154	160	159	..
36. *Daucus Carota*	165	174	179	..	(138)	191	173	122
38. *Cornus sanguinea*	168	165	171	170	164	..	136	..
62. *Thymus Serpyllum*	171	165	..	174	164	176	185	182
14. MALVA SYLVESTRIS	157	165	162	155	165	173	163	145
66. *Stachys sylvatica*	159	162	164	162	162	175	171	167
34. *Epilobium montanum*	166	168	169	161	172	171	157	171
49. *Senecio Jacobæa*	158	154	189	188	190	192	155	134
28. *Spiræa Ulmaria*	169	173	171	174	171	178	181	..
50. CENTAUREA NIGRA	171	171	174	166	177	180	186	183
56. *Ligustrum vulgare*	171	163	175	166	174	184	156	159

TABLE I.—AVERAGE DATE (DAY OF YEAR) OF FIRST FLOWERING IN EACH GROUP, 1884 *(continued).*

No. and Name of Plant.	South-West of England.	South of Thames.	Central District.	Hertford-shire.	East of England.	North of England.	Ireland.	Guernsey.
63. *Prunella vulgaris*	167	168	163	173	173	172	162	..
24. *Vicia Cracca*	172	166	169	174	173	172	180	(182)
41. *Galium verum*	181	180	179	176	183	185	236	158
52. *Carduus arvensis*	180	181	185	180	181	191	160	..
15. *Hypericum tetrapterum* ..	195	191	201	181	200	204	186	198
16. *Hypericum pulchrum*	172	174	..	180	179	183	184	172
33. *Epilobium hirsutum*	172	193	194	179	189	196	190	196
43. *Scabiosa succisa*	208	193	206	214	..	190	174	..
51. *Carduus lanceolatus*	178	190	186	164	171	195	178	..
55. CAMPANULA ROTUNDIFOLIA	190	193	200	193	197	190	189	..
57. CONVOLVULUS SEPIUM ..	186	190	199	185	187	197	196	182
65. *Galeopsis Tetrahit*	206	187	191	..	197	204	215	..
35. *Angelica sylvestris*	191	208	201	214	211	194	..	..
42. *Dipsacus sylvestris*	202	206	209	214	196	211	..	199
48. *Artemisia vulgaris*	203	203	..	216	205	210	..	..
53. *Sonchus arvensis*	190	196	196	172	179	215	201	194
61. *Mentha aquatica*	224	212	207	214	205	210	220	234
37. HEDERA HELIX	264	258	255	257	258	268	260	264

severely, and at Harpenden the damage will probably also affect next year's crop. Flowering shrubs and trees were also much damaged. At Killarney, where Lilac, Laburnum, Horse Chestnut, and Mountain Ash, were in flower in March, they of course escaped, but elsewhere the damage was deplorable. In many cases, except where the buds were very young and therefore protected by the young foliage, the flower buds were completely destroyed, and it was not till the latter part of May that any bloom at all appeared. Grass also was much affected, and the prospects of a good hay harvest were rendered very doubtful.

The only bright spot in the general tone of the Reports, is the fact that the cold dry weather was advantageous for farming operations, especially on heavy soils; but this is counterbalanced by the yellow look of the young corn at the end of the month.

The observer at Wellington College writes that where the plant had to make much growth, the flowering was backward ; but where, as in the case of the Heaths, this was not the case, the flowering was earlier than usual.

At Tiverton, the Lily of the Valley was in bud in March, but did not flower till May ; at Trowbridge, on the other hand, after the rain at the beginning of the month, the Limes burst into leaf in three days : but there, as elsewhere, the country was any thing but green at the end of the month.

Up to the 18th, plants, with very few exceptions, had flowered earlier than usual ; after this time they were almost as invariably later.

At Belton, the frost was probably the cause of the late appearance of the Swallows. Here also the bloom of the Hawthorn, Laburnum, and Horse Chestnut, was almost entirely destroyed.

May was, on the whole, a decidedly warm month, though cold at the

beginning and end; it was also dry, and this, with the severe frosts of April, acted rather prejudicially on vegetation. Those plants which were not injured by the frost, came into flower and passed away very quickly, but the flowering shrubs and trees, as Laburnum, Lilac, and Horse Chestnut, were in many places almost flowerless; on some plants, *e.g.* the Herb Robert, the effect was curious; they opened a flower and then seemed to stand still, and after some time a second would open, but the plants did not come into bloom till long after the first attempts at opening, though they seemed healthy and quite uninjured by the frosts. At Salisbury, the Herb Robert "began to flower in the second week in April, but was not frequent till the middle of May." The effect on grass was that of forcing on the bloom, and thus diminishing the undergrowth; the crop was consequently not up to the average in quantity, though the magnificent weather enabled the farmers to harvest it in first-rate condition.

Green Fly was troublesome, but grubs and caterpillars, as well as weeds and slugs, were less numerous than usual at Croydon.

The weather of June varied considerably in different districts: it is described as very cold during the first three weeks, and warm at the end; rain fell during the first half of the month, and very little afterwards. At Wells it was "remarkably fine and dry"; at Bocking and Geldeston it was "very dry"; and at Northampton "very hot and dry." At Marlborough, two heavy rainfalls did much benefit to the crops, and vegetation made great progress. Grass greatly improved, and except on very dry ground was very luxuriant: but many Reports say that the drought was severe, Strawberries wanting in sweetness, or being dried up, and being "blind"; Peas small and hard; fruit generally suffering, and Potatoes (at Wells) "making a great show above ground, but the yield of early ones small."

The profusion of bloom was remarkable, the Hawthorn especially being a mass of flower; but, as with other plants, it lasted but a very short time. Beech and Hazel Nuts promised to be very plentiful.

At Addington, Butterflies were scarce till the end of June, but White Butterflies were very abundant in some places, and "Green Fly" attacked almost all plants, cultivated and wild.

Haymaking began on June 7th at Wells, but not till July 5th at Hatton.

July was dry in the eastern counties, where the "meadows were brown and burnt up; but in the South-west of England, at Wells, it was "very wet." At Marlborough, it was certainly wet after the first week. Plants were very vigorous, and the Lime bloom was profuse. The corn was improving, but "root crops" were suffering. Peas and Lettuces were especially poor. The Wheat harvest began during the last week of the month.

Plants which had been later than usual since the middle of April, began to get in advance of their usual time.

August and September were exceptionally warm and bright, and were very dry. The crops were well gathered in, but pastures were much burnt up, Peas and root crops suffered, and the Hedgerows were unusually bare of

flowers from the want of rain; and, as might be expected, thrips was troublesome on Roses. Gardens, however, were very gay, and the foliage of the trees remarkably full and green, with very few signs of autumn at the end of September.

Wild fruits, as Haws, Blackberries, Nuts, Acorns, were most abundant, and the Hawthorns were glaring with the profusion of their scarlet fruit. Hips were not very abundant, and Dogwood and Spindle had not as much fruit as usual.

The crops were gathered in as a rule in very fine condition, and the land was in such a state that it could be thoroughly cleaned. The long continuance of drought began to be severely felt towards the end of the month, and wells were getting very low in all parts of the country.

Potatoes were very abundant and free from disease. Apples were good in some places, but the severe weather in April destroyed most of the Pears and wall fruits. With this exception, the year must be considered as having been a very favourable one.

Frog Spawn was noticed as early as February 10th at Wincanton and Cushendun, but not till March 19th at Addington. The average date is March 2nd, the same as in 1877, and one day later than in 1878 and 1882; it was twenty-four days earlier than last year, and a week earlier than the average of the ten years, thus again indicating the great mildness of the winter and early spring.

Entomological Report.

These notices are still very unsatisfactory; there are no means of checking them, as no specimens are sent in, and it is clear that some confusion has taken place.

The Honey Bee was noticed at Belton on January 26th, and at High Wick not till April 21st. The majority of the dates range throughout March, and this is probably correct. The very early dates merely indicate a sunny day, for though the sun may bring out the bees, they do not work. The real commencement of work is in March, and during April, if the weather be favourable, a great deal of honey is secured. The proverbial cold period in May stops work, and they require feeding; but after this, work is continued uninterruptedly during fine weather. This year the cold April kept the bees in their hives, and the cold period in May did not come, or was so slight, that it caused no interruption to the work of the Bees, consequently the Honey harvest was unusually fine till the dry weather came on, and flowers passed off very rapidly, rendering the latter part of the season rather unprofitable than otherwise. Early swarms were not uncommon, May 11th being the date of the first swarm at Tacolneston, and June 10th at Hodsock.

The dates for the first appearance of the common Wasp are very variable: at Salisbury the first was observed on January 20th, and at Guernsey not till July 1st; omitting this last, as probably entered under some misapprehension, it is curious that in several places a Wasp was not seen before the middle of May. Wasps were very abundant in the autumn.

TABLE II.—INSECTS AND FROG SPAWN.

Station.	80. Cock Chafer or May Bug.	81. Fern Chafer or July Chafer.	82. Bloody-nose Beetle.	83. Glow-worm.	84. Honey Bee or Common Hive Bee.	85. Wasp.	86. Large Garden White or Cabbage Butterfly.	87. Small Garden White or Cabbage Butterfly.	88. Orange-tip Butterfly.	89. Meadow-brown Butterfly.	90. St. Mark's Fly.	112. Frog Spawn.	Tadpoles.
Babbacombe	..	..	..	..	..	..	..	100	..	172	..	..	..
Westward Ho	142	..	..	145	..	129	127	127	131	141	129	..	..
Wincanton	..	..	..	145	..	74	..	..	..	..	..	41	70
Marlborough	..	..	..	..	..	..	130	123	138	176	..	59	..
Salisbury	..	..	..	..	65	20	99	98	148	..	..	57	74
Strathfield Turgiss	136	..	100	..	80	23	148	99	138	..	107	57	..
Wellington College	..	..	..	..	..	..	..	..	..	..	..	76	145
Croydon	..	..	..	..	..	..	..	..	..	..	..	53	..
Oxford	..	..	..	..	84	..	97	94	..	141	..	(78)	..
Addington	150	..	..	..	45	66	133	..	130	..	..	79	..
Watford	..	..	..	..	44	130	121	75	..	..	..	44	..
Ware	..	..	..	..	..	..	..	..	..	..	..	71	..
Harpenden	144	..	76	164	..	128	75	93	139	163	..	..	..
Hertford	..	..	..	..	..	80	119	94	131	..	..	76	..
Sawbridgeworth	..	183	..	..	112	..	..	93	..	..	..	..	..
Royston	..	..	..	..	Dec.	..	117	..	..	..	..	..	..
Cardington	..	..	..	..	29	125	..	75 ?	..	..	..	61	..
Wickham	..	..	..	..	10	..	..	..	..	177	..	..	..
Belton	150	..	..	..	6	30	131	120	131	..	..	66	..
Hodsock	..	..	..	..	swarm 162	..	..	..	141	..	..	77	..
Hatton	..	..	..	..	..	Jan.	..	..	143	..	..	69	..
Tacolneston	..	..	..	..	swarm 132	..	..	..	132	..	..	..	..
Northampton	151	..	..	..	..	119	77	79	145	..	..	54	..
Hampson	..	..	..	..	67	100	(117)	..	..	..	..	65	..
Carlisle	..	..	..	..	76	76	137	109	146	180	..	57	..
Woolaston	..	..	..	..	15	..	..	..	..	..	..	..	..
Downside	145	..	115	..	61	74	130	98	134	..	..	61	..
Streatham	..	..	..	..	58	67	..	..	..	..	..	68	82
Buildwas	..	..	..	..	..	..	..	(99)	143	..	..	..	..
Bagnalstown	..	..	..	..	..	..	..	..	..	133	..	..	..
Croxley	..	.	..	..	..	..	..	..	..	..	..	77	..
Wicklow	..	..	..	..	..	..	..	130	132	..	..	..	..
Killarney	144	..	..	..	89	..	..	116	131	149	..	47	114
Cushendun	..	..	..	..	..	100	..	105	103	143	..	41	..
Guernsey	127	..	..	..	..	183	76	101	150	133	..	..	..

Taking those dates which seem most correct, the average date for *P. Brassicæ* is May 8th, and for *P. Rapæ* April 1st. The White Butterflies generally were most abundant in some places, and the effects of the larvæ were painfully evident later on in the autumn.

The Orange-tip Butterfly seems to be the most exactly recorded of any insect. The date (April 12th) at Cushendun seems extraordinarily early, and is therefore omitted. The average of the other dates is May 17th. At Salisbury it was not seen till May 27th.

The Meadow Brown Butterfly is recorded as having been seen at Bagnalstown and Guernsey as early as May 12th; at Westward Ho and Oxford a week later; and at Carlisle not till June 28th. The average date is June 1st.

Ornithological Report.

There have been a good many changes amongst the observers, though fortunately not many among the older ones. Nine of last year's observers have ceased to send in returns, whilst thirteen new ones have taken their places, and the notices are generally complete.

Song.—The mild winter induced birds to commence their song earlier than usual. The Song Thrush began at Babbacombe in December, and generally elsewhere early in January. At Wellington College and Wickham (in Essex) it was not noticed till early in February. The average date is January 10th, the average for ten years being January 22nd.

The Skylark began singing about January 9th in Hertfordshire, beginning later as it went north, not being heard till the middle of February at St. Michael's-on-Wyre; curiously the Irish Stations report a very late date, the Skylark not being heard till the middle of March at Killarney. The average date is decidedly early compared with former years, and is a week earlier than the mean of the ten years.

The Chaffinch commenced singing later than usual; it was very early at Wickham, but as a rule it did not sing till the last week in February and beginning of March. The notices, however, vary so much that no general result can be deduced, there being an interval of nine weeks between the earliest and latest notices.

The Chiff-chaff was rather later than usual, but much earlier than last year. It was first heard at Downside, near Bath, on March 7th, but not till April 19th at Belton, an interval of over six weeks. It seems to have spread from South-west to North-east, reaching the Eastern Counties later even than at Carlisle. The latter part of March and April were very cold, and this may account in some measure for this variation.

The Willow Wren was very irregular in its movements (as far as can be gathered from the notices). It was first heard at Cushendun in Ireland, then at Belton in Norfolk, and so generally from East to West, not being noticed at Downside till more than a month later (April 24th).

The Cuckoo was well noticed. It was rather later this year than usual. It was particularly late in 1877, but otherwise its average time of appearance does not vary more than a week. The notices this year vary from March 30th at Maresfield to May 17th at Killarney, nearly seven weeks. Its general time of appearance was about the last week in April.

The Nightingale was seen at Harpenden on April 7th and at Salisbury on the 8th, but at Wincanton not till May 19th. It was later this year than in any previous one (except 1876). It was not noticed at Wellington College till June 2nd, and must have been overlooked; it was late at Oxford and very late in Norfolk, a month later than in Hertfordshire.

TABLE III.—Birds.

Station.	Song.									Migration.								
	91. Brown Owl.	93. Song Thrush.	95. Nightingale.	97. Willow Wren.	98. Chiff-chaff.	99. Sky-lark.	100. Chaffinch.	102. Cuckoo.	108. Turtle Dove.	92. Flycatcher.	94. Fieldfare.	96. Wheatear.	103. Swallow.	104. House Martin.	105. Sand Martin.	106. Swift.	107. Goatsucker.	111. Corncrake.
Babbacombe	..	−10	..	..	..	..	..	130	..	..	..	..	123	..	..	..	..	132
Westward Ho	..	..	..	105	74	..	..	108	..	..	..	86	93	86	101	107	..	120
Wincanton	..	..	139	..	..	..	..	112	..	..	..	..	103	128	..	..	..	145
Trowbridge	..	..	130	..	..	..	..	113	..	..	..	..	113	128	..	..	..	129
Marlborough	..	..	119	..	105	..	..	110	..	..	118	..	105	81	..	127	171	120
Salisbury	..	4	99	..	..	..	..	100	..	132	..	..	105	126	109	132	..	135
Strathfield Turgiss	..	4	105	100	83	12	40	103	134	..	..	92	92	101	..	111	153	122
Wellington College	..	34	153	..	..	37	..	121	..	..	146	..	106	130	..	126	130	..
Harpenden	92	2	98	..	..	9	..	106	..	..	..	..	80	117	..	121	..	142
Hertford	..	..	106	..	..	9	..	107	..	..	..	..	108	..	..	..	..	..
Sawbridgeworth	..	..	..	..	..	..	..	119	..	..	..	..	..	..	..	..	..	..
Royston	..	..	115	..	..	..	..	117	..	..	1	..	118	..	..	131	..	..
Cardington	..	..	..	..	114	..	..	117	..	..	..	..	106?	..	..	..	..	140
Maresfield	..	..	..	..	..	..	..	90	..	..	..	..	89	..	..	..	..	..
Oxford	..	..	121	..	118	20	..	117	..	141	..	..	111	..	..	127	..	124
Addington	..	..	..	..	..	..	..	114	132	..	..	..	109	..	..	130	..	165
Watford	..	..	114	..	..	15	..	114	..	..	..	..	114	..	..	..	..	..
Ware	..	..	111	..	..	10	..	109	..	..	..	..	119	122	99	126	..	..
Wickham	..	35	..	..	..	10	3	..	..	..	..	..	99	..	..	126	..	115
Geldeston	..	..	118	..	..	..	..	121	..	..	..	..	..	110	..	..	..	..
Belton	61	..	109	91	120	18	65	117	49	131	..	..	99	122	121	130	..	130
Hodsock	..	..	130	..	..	..	..	117	..	..	..	..	102	..	..	129	..	127
Hatton	..	4	..	101	..	..	54	115	..	134	..	..	117	..	..	..	..	131
Tacolneston	..	..	123	..	..	..	..	119	137	..	..	..	119	124	..	..	..	..
Northampton	36	..	115	..	..	..	..	121	..	..	..	..	109	119	127	127	..	..
St. Michael's-on-Wyre	..	..	..	..	..	45	..	122	..	84	..	120	96	121	..	..	..	..
Hampson	..	..	..	112	..	37	66	111	..	138	..	..	119	138	..	134	111	132
Carlisle	..	..	..	97	99	..	..	105	..	..	.	..	100	111	83	116	..	108
Downside	79?	..	..	115	67	23	37	117	..	131	−48	..	100	104	..	125	..	130
Croxley	..	..	106	..	..	..	..	119	..	..	..	..	106	..	..	119	..	..
Streatham	..	15	..	..	..	49	..	..	..	..	..	..	..	..	..	..	..	..
Buildwas	..	..	..	95	75	..	57	117	120	134	..	..	101	122	100	126	..	117
Hassocks	..	..	By 119	111	112	..	..	..	..	..	..	.	..	126	..	126	..	..
Wicklow	..	All Jan.	..	..	82	55	..	111	..	..	78	96	99	..	..	126	..	115
Killarney	..	..	..	..	89	72	53	138	..	..	..	..	80	..	89	121	..	123
Cushendun	..	..	..	83	..	..	..	120	..	..	..	..	108	..	..	100	..	121
Guernsey	..	..	..	..	..	..	..	99	..	..	..	..	102	115	..	..	..	129

The Turtle Dove was not much noticed. February 18th seems too early a date for it (at Belton), the average of the other dates giving May 10th as the time of its usual appearance.

Migration.—The notices of the Flycatcher and Wheatear are very few, but indicate, if any thing a rather earlier appearance than usual; but the Swallow seems to have come just about the time that the cold weather set in, and so a few were observed during the first week in April, and then no more were seen for three or four weeks. The earlier date recorded has been taken as that of the arrival of this bird, and this gives a rather earlier date than usual for its appearance; the notices vary from March 20th at Harpenden

TABLE III.—BIRDS (*continued*).

Station.	Nesting.													
	92. Fly-catcher.		93. Thrush.			100. Chaf-finch.		101. Rook.			103. Swallow.	109. Partridge.		
	Nesting.	Eggs.	Nesting.	Eggs.	Young.	Nesting.	Eggs.	Building.	Nesting.	Young.	Nesting.	Pairing.	Eggs.	Young.
Babbacombe	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Westward Ho	..	..	..	74	..	..	120	..	97	..	..	75	..	..
Wincanton	..	..	..	..	..	..	..	..	..	102	..	..	..	..
Trowbridge	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Marlborough	..	129	..	70	..	..	..	60	78	..	..	..	..	..
Salisbury	..	..	..	..	..	..	..	..	..	100	..	..	..	..
Strathfield Turgiss	..	..	..	..	..	60	..	65	..	..	..	..	..	124
Wellington College	..	..	..	66	..	..	..	..	87	..	..	..	..	..
Harpenden	..	..	..	..	..	..	..	56	..	..	..	..	..	..
Hertford	..	..	..	..	..	..	..	66	..	..	..	..	..	..
Sawbridgeworth	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Royston	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cardington	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Maresfield	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Oxford	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Addington	..	..	..	41	..	..	..	66	..	..	..	49	..	..
Watford	..	..	..	..	..	..	..	63	..	..	..	..	..	..
Ware	..	..	..	..	..	..	..	56	..	..	..	..	..	..
Wickham	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Geldeston	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Belton	..	..	65	..	106	..	..	8	..	..	..	..	..	..
Hodsock	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hatton	..	..	..	..	108	..	..	58	..	..	..	51	..	..
Tacolneston	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Northampton	..	..	..	..	..	..	..	68	..	..	..	..	..	..
St. Michael's-on-Wyre	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hampson	..	..	..	83	..	..	112	..	..	101	..	..	121	..
Carlisle	..	..	..	Sitting 102	..	..	108	..	76	..	..	..	..	..
Downside	147	..	69	74	..	133	..	57	86	..	143	47	..	..
Croxley	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Streatham	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Buildwas	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hassocks	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wicklow	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Killarney	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cushendun	..	..	..	..	..	..	..	32	48	..	..	..	..	..
Guernsey	..	..	..	..	..	..	..	..	..	..	..	..	..	..

and Killarney to April 20th in Norfolk, the majority being during the last half of April.

The Sand Martin appeared generally after the Swallow, but at Carlisle it was seventeen days, and at Harpenden twenty days earlier. There seems to be some error here, and the dates from these places have not been taken in calculating the average. Even omitting the early records, the bird was two days earlier than last year.

The House Martin, unlike the Swallow, was later than in any previous year, the dates of appearance varying over an interval of nearly six weeks; it appears to have been most generally seen during the first week in May.

The Swift was remarkably early, eight days before its average time. Its general time of arrival was the first week or ten days of May, when the weather became warmer. It has been observed, however, that temperature does not seem to influence its arrival in England. An examination of its average time of arrival during the past fifteen years shows that it is, perhaps, the most irregular of these spring migrants.

The dates for the Corncrake vary from April 17th at Carlisle to June 13th, at Addington, an interval of eight weeks. There must be some want of observation, as the bird makes its presence known as soon as it arrives; it is curious that it should have been noticed first at Carlisle.

NESTING.—The only species sufficiently observed is the Rook. Considering the very warm winter, it is not surprising that it began its building very early, quite a week before the average date.

Taking a general summary, the season was an early one, except during the latter part of April. It was just this part of the year which was so unusually cold. Till the second week in April, the temperature had been almost invariably above the mean, two weeks only (at different times) having a temperature below the average of the previous ten years.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

NOVEMBER 19TH, 1884.

Ordinary Meeting.

ROBERT H. SCOTT, M.A., F.R.S., President, in the Chair.

ROBERT AITKEN, Colmonell, Girvan, N.B.;
NAHUN E. BALLOU, M.D., Ph.D., Sandwich, Illinois, U.S.A.;
FRANCIS CAMPBELL BAYARD, L.L.M., Oaklands, Harcourt Road, Wallington;
GEORGE WOULFE BRENAN, Assoc.M.Inst.C.E., Craigvarren, Oban, N.B.;
HERBERT THOMAS BURLS, F.G.S., Sarawak, Borneo;
ALFRED CHADWICK, M.D., M.R.C.S., 131 York Street, Heywood;
RICHARD COOKE, The Croft, Detling, Maidstone;
PETER HENRY EMERSON, B.A., M.R.C.S., Wellesley House, Southwold;
SAMUEL JOHNSON, M.B., F.R.A.S., 23 Gloucester Terrace, Hyde Park, W.;
GEORGE JAMES LEE, Central Jones Street, Kimberley, South Africa;
ROBERT MONTAGUE MERCER, Rodmersham House, near Sittingbourne;
LEWIS POTTER MUIRHEAD, Rosemount, Helensburgh, Dumbartonshire;
JOHN DAVID WILLIAM VAUGHAN, Suva, Fiji; and
JOSEPH BOWMAN WILSON, Kirklandhow, Arlecdon, *viâ* Carnforth,
were balloted for and duly elected Fellows of the Society.

The following Papers were read:—

"A NEW METHOD OF READING THE DIRECTION OF THE WIND ON EXPOSED HEIGHTS, AND FROM A DISTANCE." By HUGO LEUPOLD, F.R.Met.Soc. (p. 1).

"DESCRIPTION OF A COMPONENT ANEMOGRAPH." By ALFRED NAYLOR PEARSON, F.R.Met.Soc. (Abstract.)

In May 1883 an idea occurred to the author for the construction of a mechanical arrangement which, when coupled with the cups and vane of a

Robinson-Beckley Anemograph, would give traces of the longitudinal and latitudinal wind components. During the last few months the author has worked out the idea in detail. The arrangement for resolving the wind movements into their components is something similar to the one described by Mr. Walter Baily, F.R.Met.Soc., in the *Philosophical Magazine* of September 1882,—and the author states that he did not see Mr. Baily's paper until a recent date, and did not know that an arrangement on a similar principle had been devised by any one but himself. The following is a brief description of the instrument :—

The spindle of a wind vane is attached at its lower end to a crank free to revolve in a horizontal plane, which crank causes two horizontal slides to move with reciprocating motion.

One slide is fixed to move only in an East and West direction, the other North and South. Each slide drags with it the axis of a heavy vertical wheel, which rolls on the horizontal surface of a disc or circular table, which is at the same time being rotated by means of gearing down from the Robinson's cups. The vertical wheel, being simultaneously shifted under the action of the vane to or from the centre of the table, revolves with a velocity proportional to that of the cups multiplied by the sine of the angular movement of the vane.

The reduced motion of the vertical wheels is eventually transmitted to pencils, which record on paper wrapped round a clock-driven cylinder in the ordinary manner.

The remainder of the paper is occupied by a detailed description of the apparatus proposed to be employed, copious references being made to the elaborate drawings furnished by the author.

These, however, not being of sufficient general interest to engrave, are preserved in the archives of the Society for reference.

(For the discussion on this Paper, see p. 6.)

"On the Injury by Lightning to the Monument to the First Duke of Sutherland, at Lilleshall, Shropshire, April 28th, 1884." By Charles Clement Walker, F.R.A.S. (p. 7.)

"On the Mechanical Characteristics of Lightning Strokes." By Col. the Hon. Arthur Parnell. (p. 12.)

December 17th, 1884.

Ordinary Meeting.

Robert H. Scott, M.A., F.R.S., President, in the Chair.

Charles Harrington Cotton, Abbots Hayes, Chester ;
Samuel Aird Jolly, L.R.C.P., L.R.C.S., Ilsington Lawn, Piddletown ; and
Rev. Charles Johnson Taylor, M.A., Toppesfield Rectory, Halstead,
were balloted for and duly elected Fellows of the Society.

Mr. J. S. Harding and Mr. H. S. Wallis were appointed Auditors of the Society's Accounts.

The following Papers were read :—

"On the Reduction of Temperature Means from Short Series of Observations to the Equivalents of Longer Periods." By Dr. Julius Hann, Hon.Mem.R.Met.Soc. (p. 28.)

"The Diversity of Scales for Registering the Force of Wind." By Charles Harding, F.R.Met.Soc. (p. 39.)

"Report on the Phenological Observations for 1884." By the Rev. T. A. Preston, M.A., F.R.Met.Soc. (p. 47.)

CORRESPONDENCE AND NOTES.

THE METEOROLOGIST'S VANE OR ANEMOSCOPE.—An invention for facilitating the determination of the true direction of the wind from the indications of a vane or weathercock at a distance. By G. M. WHIPPLE, B.Sc., F.R.Met.Soc., Superintendent of the Kew Observatory.

AT a convenient distance, say one or two feet below the ordinary wind vane, arrow, or weathercock, I affix rigidly to the shaft bearing or sleeve forming its support, in such a way or manner as to partake of its movement of revolution in a horizontal plane, a frame of metal, wood, or similar hard inflexible material, either in the shape of a cross, radiating bars, or a wheel, which supports at right angles at the extremities of the radiating bars in the manner of the ordinary vanes or weathercocks, the four metal letters, N, E, S, and W, placing them so that the two pairs of letters N and S, or E and W, shall be in two separate and distinct horizontal planes, N and S being either above or below the other pair E and W as may be desired, and as is represented in the figures 1 and 2.

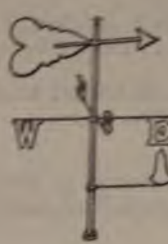


FIG. 1.

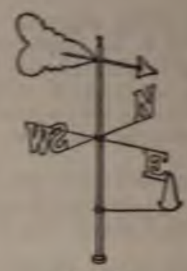


FIG. 2.

2nd. To the upright spindle or axis carrying the vane and direction frame or cross, or to some convenient support close to or adjacent to it, I affix a rigid metallic or other material rod, ornamental or plain, directed upwards or horizontally towards the letters N E S W, which serves as a pointer or indicator, and which is so constructed as to be moveable around the upright support of the vane or weathercock, and capable of being rigidly clamped or fixed by screws, pins, nuts, wedges, or other means, so that it may be placed in any situation convenient and suitable for indicating the direction of the wind from the particular position from which it is desired to view the vane. The instrument is made by Mr. J. Hicks, of Hatton Garden.

CONDENSATION THEORY OF THE GENERATION OF CYCLONES.

PROF. J. Eliot, in a recent paper[1] read before the Asiatic Society of Bengal, gave an account of the South-west Monsoon Storms of June 26th to July 4th, and of November 10th to 15th, 1883. The first storm was generated during the last week of June near the head of the Bay of Bengal, and gave very stormy weather off the Bengal and Orissa coasts, and was the only occasion on which it was necessary to hoist the storm signals at the Langor Island station, near the entrance to the Hooghly. The second storm was formed in the Gulf of Martaban, during the second week of November, almost at the end of the South-west monsoon, and pursued a very unusual course. It crossed into the Bay of Bengal through the channel between Cape Hegrais and the Andaman Islands.

[1] *Journal of the Asiatic Society of Bengal*, Vol. LIII. Part II. No. 2, August 1884.

It then slightly recurved, and moved in a general northward direction, approaching the Arracan coast near Akyab, where it was broken up by the action of the Arracan Hills.

Having given all the observations and discussed their more important features, Prof. Eliot proceeds to explain the chief features of these two storms as physical phenomena, and also to suggest the theory of cyclonic generation and motion which appears to be applicable to them, and is consistent with our knowledge of the physics of the atmosphere. He says :—

"In both examples, the greater portion of the mass of air that was thrown into a state of violent motion during the storm was for some days antecedent to the disturbances almost at rest, and in a state of approximate equilibrium. There was a break in the rains immediately preceding the formation of the first storm, which is well known to be a period of light and unsteady winds in Bengal, and over the head of the bay. The second storm occurred very shortly after the first break in the North-east Monsoon rains on the Coromandel coast, and when, as the various observations prove, winds were very light and variable over the greater portion of the bay. Hence the first and most striking feature of these cyclones was that a vast amount of kinetic energy or motion was rapidly given to a large mass of air, which previously to that action was in an almost quiescent state. The gradual increase of the motion was in those two examples proved from observations taken by vessels passing through the areas of disturbance. The transformation from the state of approximate quiescence to that of violent cyclonic motion in the bay is consequently a continuous process, the successive stages of which can be fully traced. And the entire development of these, and of all storms in the Bay of Bengal, appears to be due to actions occurring over the bay itself, and not to atmospheric conditions at a considerable distance from the arc of cyclonic disturbance.

"The question of cyclone generation is therefore essentially one of transfer of energy. Viewed in this light there are two subjects for inquiry :—1st. The source and character of the energy which is transferred to the atmosphere, and transformed into the kinetic energy of a mass of air. 2nd. The conditions necessary for the transfer of energy under consideration.

"If these two questions are fully answered, a satisfactory explanation will be given of cyclonic generation as a meteorological problem. The complete mathematical treatment of this subject as a dynamical question is beyond the scope of the present article.

"The energy which is transformed during the generation and existence of a cyclone, and which maintains the cyclonic circulation against the various resistances opposing it and therefore tending to disintegrate it, is undoubtedly the latent heat energy given out during the condensation of aqueous vapours contained in the atmosphere. In all cyclones of the Bay of Bengal that have hitherto been investigated, heavy and in the majority of cases, torrential rain is the most prominent feature. It increases in amount during the generation of the cyclone, is excessive during the existence of the cyclone in its complete form, and rapidly decreases during the disintegration of the cyclone, ceasing with the disappearance of the cyclonic vortex. It is thus a phenomenon parallel in character and duration with the cyclonic motion or disturbance.

"It is also equally certain that when aqueous vapour is condensed into rain, practically the whole of the solar thermal energy utilised to perform the work of evaporation is given out by the mass of vapour during condensation, and is transferred to the adjacent mass of air. Major Cunningham's hydraulic experiments at Roorkee appear to establish that the sun's heat under the most favourable conditions, that is, with dry weather and high air temperature, does not evaporate more than one-tenth of an inch *per diem* from the surface of slowly moving water. The inverse process of condensation in consequence of certain features of air motion dependent on rainfall usually proceeds much more rapidly, and frequently restores the aqueous vapour in the form of rain to the earth's surface at the rate of one to two inches per hour. Prolonged rainfall at the rate of 10 to 30 inches *per diem* for periods varying from 24 to 72 hours is by no means uncommon during the passage of the larger cyclones of the Bay of Bengal across the Bengal or Madras coasts. It is probable, judging from the expressions used by sailors to describe the rainfall during cyclones in the Bay, that it is more intense and prolonged than on land.

"If we therefore compare the rates at which evaporation and condensation can occur, it is certain that the energy released during the act of condensation is transferred to the atmosphere with very great rapidity during heavy rainfall, and probably at a rate occasionally amounting to 100, 200, or even 400 times that at which it was absorbed during the process of evaporation. The effect of a continuous fall of 20 or 30 inches of rain over any portion of the earth's surface would, on the assumption of Major Cunningham's results, be equivalent to that of a sun 250 times as powerful as our present luminary acting directly on the mass of the atmosphere above the area of rainfall, instead of indirectly by means of convection currents due to the heating of the earth's land surface. The action is also usually continuous, and is not interrupted, as in the case of the direct solar action, by the succession of night and day. There is therefore the strongest probability that so powerful a disturbing action can produce very large and rapidly accumulating effects on the mass of the earth's atmosphere affected and influenced by it in a comparatively short space of time.

"There hence appears to be no doubt that the energy transferred to the atmosphere during heavy rainfall is very large, and that the source of the energy thus indicated is adequate, from every point of view, to account for the production of the largest and most intense cyclonic circulations. Other causes of the origin of cyclones have been assigned, as, for instance, differences of pressure, friction between parallel winds blowing from opposite directions, &c.; but the slightest consideration seems to show that none of these is sufficient to account for the enormous and continuous transfer of energy that occurs during the prolonged existence of a large cyclone. The strongest argument against these theories, in the case of cyclones of the Bay of Bengal, is, that experience has established that the larger the cyclone, the smaller are the antecedent differences of pressure, and the feebler are the winds blowing from opposite directions, immediately before the formation of the cyclonic vortex.

"The following statements, based on the preceding remarks, hence give the answer to the first part of the required explanation. When water is converted into aqueous vapour on the large scale at the earth's surface, thermal energy, derived from the sun, performs the work of evaporation, and is hence transformed. The aqueous vapour thus produced possesses an equivalent amount of energy, the greater part if not the whole of which it retains so long as it continues in the vaporous condition. When it is reconverted into water, or condensed as rain, this portion of its total energy is given out, and transferred to the air. The *modus operandi* of this transfer is a matter of no importance in the present inquiry. Also, in all cases when the rainfall is heavy, and prolonged for a considerable time, the energy is given out at a much more rapid rate than that at which it was absorbed during the process of evaporation. Hence heavy and prolonged rainfall may give rise to a powerful, persistent, and continuously accumulating disturbance in the adjacent atmosphere, and, therefore, produce violent and extensive air motion. In virtue of the constitution of the atmosphere, the motion will be rotatory. Prolonged heavy local rainfall is hence an adequate and sufficient cause. It is, moreover, the only known cause which is equal or similar in amount to the effect, and hence there are strong reasons for assuming that it is the motive power which produces the peculiar motion of the atmosphere called cyclonic circulation on the large scale. It is, in fact, the most powerful disturbing action to which the air is subject; and the consequent motion of the air is, when the rainfall and consequent disturbance are excessive, the most violent in its character with which we are acquainted.

"The history of the two cyclones has shown most fully that heavy rainfall over the area of cyclonic motion or disturbance was a characteristic feature, and that in this respect they confirm previous experience. Hence the source of the energy of these two cyclones was almost certainly that which we have indicated in the previous statement, that is, the latent heat energy of the aqueous vapour derived previously from the sun, and transferred to the atmosphere during the process of condensation.

"As rainfall does not always appear to produce cyclonic motion, it is clear that although rainfall may be the source of energy, it is only when the rainfall occurs under special conditions that the accompanying air motion increases and accumulates in the peculiar manner necessary to give rise to a large and intense cyclonic circulation. Experience has shown that the

following conditions, which can be proved to have a direct bearing on the formation of cyclones, are always present before and during the generation of cyclones in the Bay of Bengal:—

"1st. The establishment and prevalence of a humid current over the extreme south of the Bay, which brings up large quantities of aqueous vapour into the centre or north of the Bay.

"2nd. The occurrence of approximate uniformity of meteorological conditions, more especially of pressure, over the coasts of the Bay, and frequently over a considerable portion of the Bay.

"3rd. The prevalence of light and variable winds over Bengal and the coasts southwards. This condition is practically identical with the previous, as both are due to, and accompany, the same general atmospheric conditions.

"4th. The absence of rainfall, and the prevalence of clear skies with fine weather, over the north and centre of the Bay, and in Bengal.

"The relative importance of these conditions will be evident on very brief consideration. The first is undoubtedly necessary to supply the aqueous vapour in sufficiently large amounts to give rise to a continuous heavy rainfall over such a large area as is covered by a considerable cyclonic disturbance. The Bay of Bengal is not a large enough evaporating area to afford such a supply. Hence cyclonic storms are only formed in the Bay of Bengal when there is a humid current blowing into it from the Indian Ocean. This occurs only during the South-west winds blowing at the entrance of the Bay or the Northward continuation beyond the Equator at the South-east Trade Winds of the Southern Tropics. That such is the case is sufficiently proved by the fact that cyclonic storms on the large scale are entirely restricted to that portion of the year when South-west Monsoon winds are blowing over a part or the whole of the Bay, that is, from the beginning of May to the end of December. It is also shown by the fact that, at the commencement and termination of the South-west Monsoon period, any cyclones that are generated form in the South of the Bay, whilst in the months of July and August, or during the height of the South-west Monsoon, they form near the Head of the Bay. In short, the area of cyclonic generation in the Bay of Bengal depends mainly upon the season, and travels Northwards or Southwards, according as the South-west Monsoon is advancing or retreating over the Bay.

"The remaining conditions appear to be necessary in order that the rainfall may occur in such a manner as to give rise to and produce an atmospheric whirl. It is evident that if rainfall tends to set up a rotatory motion in the air, it is absolutely necessary for rotatory motion on the large scale that there should not be several separate centres of rainfall and disturbance, each producing its own rotatory or cyclonic action, and therefore interfering with the others. It is essential that the rainfall should be localised and concentrated, that it should continue for some time over a comparatively small area, and be confined to that area. The more perfectly this is realised, and the longer this continues, the greater will be the accumulated disturbance. In order that the rainfall may occur over the same area for such a considerable period as to permit of the continuous accumulation of action, it is evident that ascensional motion should mainly occur there, and hence that, previously, there should be little horizontal motion of the air, and therefore very slight differences of pressure at the sea level. The necessity for the further conditions is hence also evident.

"It will be seen that these conditions were fulfilled in the case of both storms, more completely (as might have been anticipated) in the case of the second storm, when the South-west Monsoon current was weaker than it was at the time of the first storm. The history and discussion thus fully bear out the existence of the conditions immediately antecedent to the two storms which the condensation theory asserts to be necessary for the initiation and generation of a cyclonic storm in the Bay.

"The preceding remarks hence indicate that the energy given out during the process of aqueous vapour condensation on the large scale is the motive power of cyclones, and that the rainfall must be localised and concentrated over a considerable area, for a period of one or more days, in order to produce the continuous and rapid accumulation of energy which characterises a large cyclonic disturbance. Experience has also shown that the conditions which the condensation theory suggests as being essential for the occurrence of continuous and pro-

longed local rainfall over a portion of the Bay are exactly those which are present before and during all cyclonic storms in the Bay of Bengal, and that they are more fully marked before the occurrence of the larger than of the smaller cyclones of the Bay. It is, moreover, these antecedent conditions which form the only test or indication of the possible or probable early formation of cyclones in the Bay, and which are utilised in the preparation of the daily weather reports issued by the India and Bengal Meteorological Departments."

RECENT PUBLICATIONS.

American Meteorological Journal. A Monthly Review of Meteorology and allied Branches of Study. Vol. I. Nos. 7-9, November 1884-January 1885. 8vo.

The principal articles are:—Local and topical Weather Cards, by W. M. Davis (3 pp.).—Weather Areas and their Movements, by L. A. Sherman (4 pp.).—The Thunder-squalls of July 5th, by H. H. Clayton, Junr. (15 pp.).—Solar Heat and Terrestrial Dilatability, by F. D. Covarrubias (20 pp.).—New England Meteorological Society, notice of First Annual Meeting at Boston on October 21st (5 pp.).—Thermometer Exposure, by H. M. Paul (8 pp.).—Local Weather Lore, by A. W. Butler (4 pp.).—Self-recording Mercurial Barometer, by Dr. D. Draper (3 pp.).—Determination of Air Temperature and Humidity, by H. A. Hazen (5 pp.).

Annales de l'Observatoire Impérial de Rio de Janeiro. Publiées par L. Cruls. Tome II. Observations et Mémoires, 1882. 4to. 1883.

In addition to a large amount of astronomical information, this gives in full the meteorological observations made seven times each day at the Imperial Observatory, Rio de Janeiro, during the year 1882; also the monthly results at Queluz, Itabira do Campo, and Rio Grande do Sul.

Annales de l'Observatoire Royal de Bruxelles. 4to. 1885.

Contains:—Discussion des Observations d'Orages faites en Belgique pendant l'année 1879, par A. Lancaster (58 pp.). The number of observers of thunderstorms was about seventy; and from a discussion of the observations the author formulates the following results:—1. Thunderstorms occur under the influence of atmospheric depressions; 2. They occur chiefly, in Belgium, when the centre of the depressions is to the West, West-north-west, or North-west of Brussels; 3. Electrical phenomena attain their maximum of intensity and development when the depressions have their centre in Ireland, or near its coasts; 4. Thunderstorms appear most frequently with barometric pressures between 750 and 755 mm. (29·5 to 29·7 ins.); 5. With high barometric pressure they are very rare; 6. The direction they take is generally South-west to North-east; 7. Their mean velocity is from 40 to 50 kilomètres per hour; 8. The rainfall which accompanies the storms is more intense in the West than in the East of the country; 9. Thunderstorms consist of small atmospheric depressions possessing all the characteristics of large depressions, of which they are in some measure satellites; 10. These storms depend on two most important meteorological factors, viz. temperature and atmospheric pressure. An increased temperature at the time of a barometric depression is the most favourable circumstance. An increased temperature without depression, and *vice versâ*, does not bring on storms; 11. The hour at which thunderstorms usually occur is that which coincides with the time of the diurnal maximum temperature and minimum pressure; and 12. A slight gradient is favourable to their production.

Annuaire de la Société Météorologique de France. Vol. XXXII. Avril-Mai 1884. 4to.

Contains:—L'Orage du 1er février 1884 à Tours, par M. de Tastes (5 pp.).—Sur la Détermination de la Température de l'Air en Mer, par L. Teisserenc de Bort (3 pp.).—Mouvements de l'Air au-dessus d'une Dépression ou d'un Surhausse-

ment barométrique, par M. A. Poincaré (7 pp.).—Baromètre à Glycerine, par M. Caron (3 pp.).—Schémes des Mouvements atmosphériques sur l'Europe dans les divers régimes, par M. Poincaré (7 pp.).—Résumé des Observations météorologiques faites à Constantinople de 1856 à 1875, par M. C. Ritter (25 pp. and plate).

Annuaire de l'Observatoire Royal de Bruxelles, 1885. 52e Année. 12mo. 1884. 374 pp.

In addition to much valuable information, this contains a paper by M. J. Vincent on the climatology of Brussels (35 pp. and plate). This is a discussion of the observations made during the fifty years 1833-1882.

Ciel et Terre. Révue populaire d'Astronomie, de Météorologie, et de Physique du Globe. Vol. V. Nos. 17-22. November 1884-January 1885. 8vo.

The meteorological articles are :—Les Climats marins et les Climats continentaux au point de vue de la Végétation, par M. Bergsman (5 pp.).—Les Tempêtes d'Equinoxe (3 pp.).

Journal and Proceedings of the Royal Society for New South Wales for 1883. Vol. XVII. 8vo. 1884.

Contains :—Some Facts bearing upon Irrigation, by H. C. Russell (3 pp.). The author has been carrying on some experiments to find out how much rainfall goes to supply vegetation and evaporation, and, so far as he has gone, the evaporation from the grass appears to be about 1½ times, and from earth about twice, that from water. When the grass is very wet its loss is sometimes 2½ times that from water, and that from the soil has been as much as 3½ times that from water.—Irrigation in Upper India, by H. G. McKinney (10 pp.).—Tanks and Wells of New South Wales, Water Supply and Irrigation, by A. P. Wood (34 pp.).

Meteorologische Zeitschrift. Herausgegeben von der Deutschen Meteorologischen Gesellschaft. Redigirt von Dr. W. Köppen. 1884. Nos. 9-12. September-December. 4to.

Contains :—Die mittlere Bewölkung einer Periode als Funktion ihrer hellen und trüben Tage, von Dr. Grossmann (8 pp.). This subject has also been handled by Herr Mantel in Vol. XIX. of the *Annalen der Schweizerischen meteorologischen Central-Anstalt* for 1882. The formulæ employed by the two authors are nearly identical :—

$$\text{Grossmann gives } C = 53 + \frac{45}{n}(D - B)\text{; Mantel gives } C = 51 + \frac{45}{n}(D - B)$$

where C = the mean cloudiness of the period ; n = the number of days ; D = the number of dark days ; and B = the number of bright days.—Die Untersuchungen von Pater B. Viñes über westindische Orkane, besprochen von W. Köppen (8 pp.).—This is a review of Padre Viñes' work on the hurricanes of September and October 1875 and 1876 in the Antilles. Three hurricanes are discussed, with the help of the U. S. Signal Office Observations. Among the most remarkable facts to which attention is drawn is the variation in intensity of each of these hurricanes during their progress, the first two passing over Cuba with diminished force, while they were excessively violent before and after they visited the Havana. In these two storms the Easterly winds on the northern side of the path were as usual the strongest; in the third the contrary was the case. The maximum gust experienced was one lasting for four seconds at the rate of 100 miles an hour. The author gives in great detail his account of the sky appearances and various non-instrumental observations which preceded the storm.—Ueber zwei neue Registrirapparate für Windesgeschwindigkeit und Windrichtung, von R. Fuess (7 pp.).—Ueber den von Nipher vorgeschlagenen Schutztrichter für Regenmesser, von Prof. R. Börnstein (7 pp.). This is an account of a series of experiments made at Berlin with Nipher's protecting funnel for

rain-gauges. The results show that the funnel does increase the amount collected, and that its action is greater the stronger the wind.—Zum Studium der Regenfälle mit Rücksicht auf die Regenprognosen, von Dr. A. Winkelmann (5 pp.).—Die Bedeutung synoptischer Studien im Südatlantischen Ocean, von Dr. G. Neumayer (5 pp.).—Eine rationelle Methode zur Prüfung der Wetterprognosen (8 pp.).—Graphische Methode zur Bestimmung der adiabätischen Zustandsänderungen feuchter Luft, von Dr. H. Hertz (10 pp. and plate). This investigation on the changes induced in moist air by elevation is similar to that of Dr. Hann,[1] but it gives a diagram by which to determine how much will be condensed, and how much will remain in the state of vapour at each level.—Ueber Messung der Niederschlagshöhen, von C. Lang (6 pp.). This paper shows how, in Bavaria, stations close to each other do not give accordant rain results, and notably that the mode of snow measurement is very unsatisfactory.—Principien der Vertheilung meteorologischer Stationen, von Dr. W. Köppen (6 pp.).—Klima von Ostsibirien, von Dr. A. Woeikof (18 pp.).—Among other points the author shows the extremely low temperatures recorded at Werchojansk and Yakutsk to be purely local, and confined to the valleys in which these stations are situated. He also mentions that barometrical readings of 31·5 ins. have really been observed, but in Western, not Eastern Siberia.—Ombrograph mit Sinuswage, von Capt. G. Rung (3 pp.).

Proceedings of the Royal Society. Vol, XXXVII. Nos. 233-234. 8vo. 1884.

Contains :—Report to the Solar Physics Committee on a comparison between apparent inequalities of short period in sun-spot areas and in diurnal temperature-ranges at Toronto and Kew, by Balfour Stewart, F.R.S., and W. L. Carpenter (27 pp.). The results obtained are as follows :—1. Sunspot inequalities around twenty-four and twenty-six days, whether apparent or real, seem to correspond closely in period with terrestrial inequalities, as exhibited by the daily temperature range at Toronto and at Kew. 2. While the sun-spot and the Kew temperature-range inequalities present evidence of a single oscillation, the corresponding Toronto temperature-range inequalities present evidence of a double oscillation. 3. Setting the inequalities as the authors have done, the sun-spot maximum occurs about eight or nine days after one of the Toronto maxima, and the Kew maximum about seven days after the same Toronto maximum. 4. The proportional oscillation exhibited by the temperature-range inequalities is much less than that exhibited by the corresponding solar inequalities.—Report of the Kew Committee for the year ending October 31st, 1884 (22 pp.).

Professional Papers of the Signal Service. No. XIV. Charts of Relative Storm Frequency for a portion of the Northern Hemisphere. By John P. Finley, Serjeant, Signal Corps, U. S. A. 4to. 1884. 9 pp. and 18 charts.

This memoir contains a series of charts illustrating by coloured areas the monthly and annual distribution of tracks of centres of barometric minima over North America, the North Atlantic, and Europe. The work necessarily offers only approximate results, and the combination of a greater number of years will probably change more or less the configuration of the areas of relative frequency as now charted. The tables and charts are given without discussion, and no attempt is made to account for or explain away any of the evident peculiarities of the distribution of storm frequency.

Report on the Meteorology of India in 1882. By Henry F. Blanford, F.R.S. Meteorological Reporter to the Government of India. Eighth year. 4to. 1884. 450 pp.

This volume contains the monthly and annual results of meteorological observations for about 130 stations in various parts of India, and also the monthly and annual rainfall at 457 stations. The weather may be briefly summarised as

[1] *Zeitschrift der österreichischen Gesellschaft für Meteorologie.* Vol. IX. p. 328, 1874.

follows :—On the whole, the year 1882 was cooler than the average, and most so in the first two months of the Monsoon, when the precipitation was excessive; but both the early and closing months had a somewhat excessive temperature, both these seasons being very dry and comparatively rainless. The atmospheric pressure was rather below the average, but it was subject to many vicissitudes, differing in this respect from the condition of some years previously. The absolute humidity of the atmosphere and the quantity of cloud were both lower than usual, but the rainfall on the average of the whole area was excessive, being higher than in any year since 1878. In both peninsulas, and in Western India, the excess was universal; and, in India proper, due to the strength of the western branch of the Monsoon. Indeed, the only provinces in which the rainfall was short of the average were Bengal and Assam, the whole of the Gangetic plain, and the Punjab; the greatest deficiency being in Bengal.

SYMONS'S MONTHLY METEOROLOGICAL MAGAZINE. Vol. XIX. Nos. 226-228. November 1884-January 1885. 8vo.

The principal contents are:—The Thunderstorms of 1884 (11 pp.).—A Tornado at Ely, by J. H. White (1 p.).—Heavy Rain in the North-west of Scotland (2 pp.).—Distribution of Rain in Ceylon during the decade 1871-1880, by Prof. V. Raulin (2 pp.).

TRANSACTIONS AND PROCEEDINGS OF THE ROYAL SOCIETY OF VICTORIA. Vol. XX. 8vo. 1884.

Contains:—Notes of the Rainfall Map recently issued by the Government of Victoria, by R. L. J. Ellery, F.R.S. (3 pp.). The prominent facts displayed by this new map are:—1. That the greatest rainfall takes place on the coast lines, or on the summits of the high ranges, especially near the coast; 2. That the areas immediately in the lee of these ranges have a markedly lessened rainfall; and 3. That were it not for the mountain ranges, it appears probable that the amount of rainfall in the southern and eastern portions of Australia would decrease gradually from the coast line to the central regions of the continent.—The Recent Red Sunsets, by R. L. J. Ellery, F.R.S. (2 pp.).

TRANSACTIONS OF THE DEVONSHIRE ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, LITERATURE AND ART, 1884. Vol. XVI. 8vo.

Contains:—A Contribution to the Comparative Meteorology of Torquay, Teignmouth and Sidmouth, by Dr. W. C. Lake (10 pp.). This is a short discussion of the climatological observations made at the above places during the three years 1880-1882.

ZEITSCHRIFT DER ÖSTERREICHISCHEN GESELLSCHAFT FÜR METEOROLOGIE. Redigirt von Dr. J. HANN. November 1884-January 1885. Vols. XIX.-XX. 8vo.

Contains:—Beiträge zur Klimatologie der Griechischen Halbinsel, von Prof. J. Partsch (9 pp.). This is the author's second contribution to the climatology of Greece. In this paper he gives an analysis of the observations made in Athens at Baron von Sina's observatory by the late Dr. Schmidt. The values given are mostly the results of twenty-four years' observations, 1859-1882.—Das Polarlicht in dem Karischen Meere während der Ueberwinterung 1882-1883, von Dr. H. Ekama (4 pp.).—Bemerkungen zu einer klimatologischen Tafel der meteorologischen Station Omaruru (Damaraland), von Dr. A. v. Danckelman (4 pp.).—Ueber die Beziehungen der Hydrodynamik zur Theorie der Bewegungen der Atmosphäre, von Prof. A. Oberbeck (2 pp.).—Ueber den täglichen Gang des Luftdruckes auf dem Säntis und Grossen St. Bernhard, von Dr. Maurer (11 pp.).—Ueber die Trägheitsbahn auf der Erdoberfläche, von F. Roth (6 pp.).—Bemerkungen über die Temperatur der ostasiatischen Inselreihe, Sachalin, Yezo, und Nippon, von A. Woeikoff (3 pp.). The author adduces evidence to show that the west coasts of these islands are warmer than the east, notwithstanding that the Kuro-Siwo flows along the east side.—Die verticale Vertheilung der Temperaturschwankungen um den Frostpunkt in der Schweiz, von Dr. A. Rodler (5 pp.). This is a comparison of the number of

times the sign of the temperature observations has changed from + to —, and *vice versâ*, at each station. This gives some indication of the frequency of thaws, and consequently of the amount of erosion of the rocks produced by streams. The results show that for such oscillation about the freezing point Wojeikof's principle for daily range holds good, viz.: Convex contours of the country diminish daily range, concave contours increase it.—H. Mohn: Tabellen zum Klima von Norwegen. 1. Relative Feuchtigkeit (10 pp.).

Zeitschrift des Königlich preussischen Statistischen Bureaus, Jahrgang 1884. 4to. 1884.

Contains:—Grösste Niederschlagsmengen in Deutschland, mit besonderer Berücksichtigung Norddeutschlands, von Dr. G. Hellmann (11 pp.).

LEUPOLD'S ANEMO

FIG. 1.

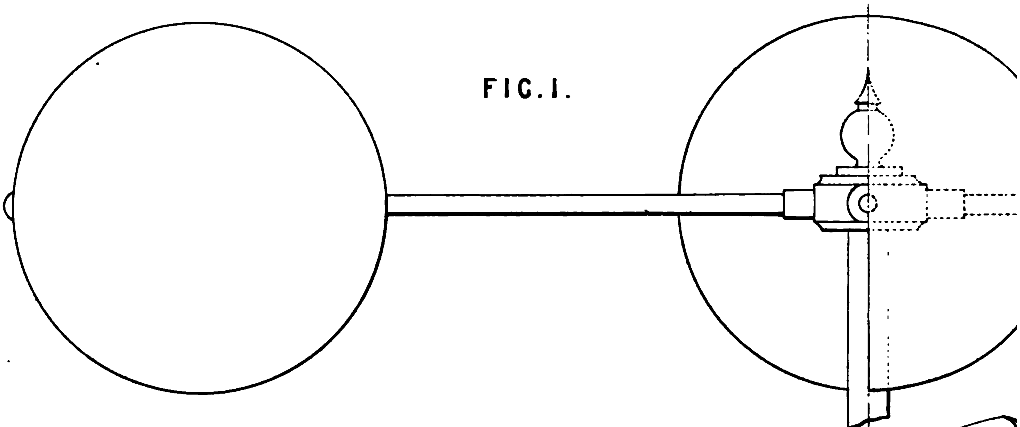
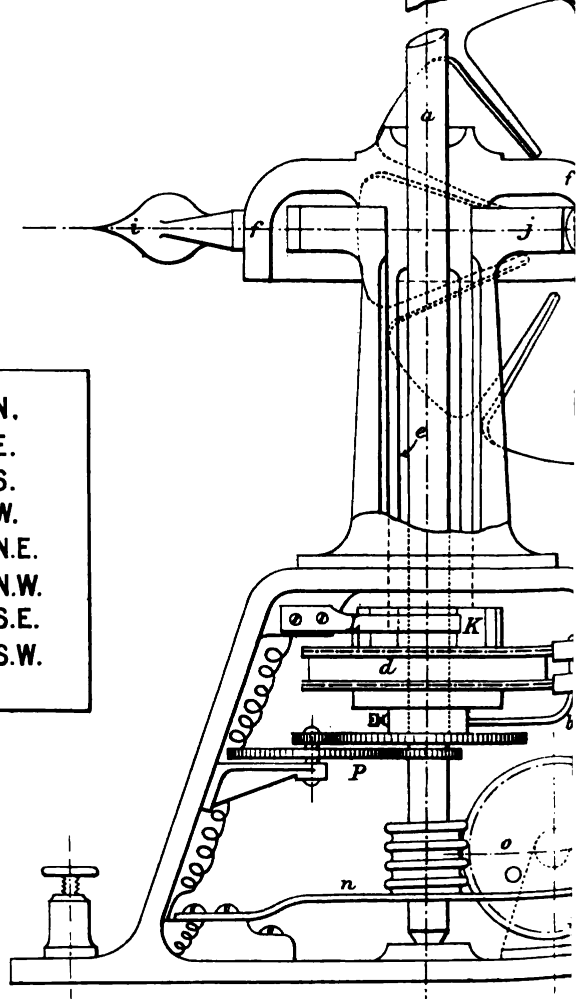
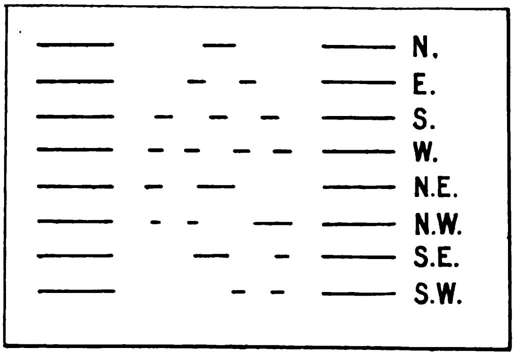



FIG. 3.



RAPH.

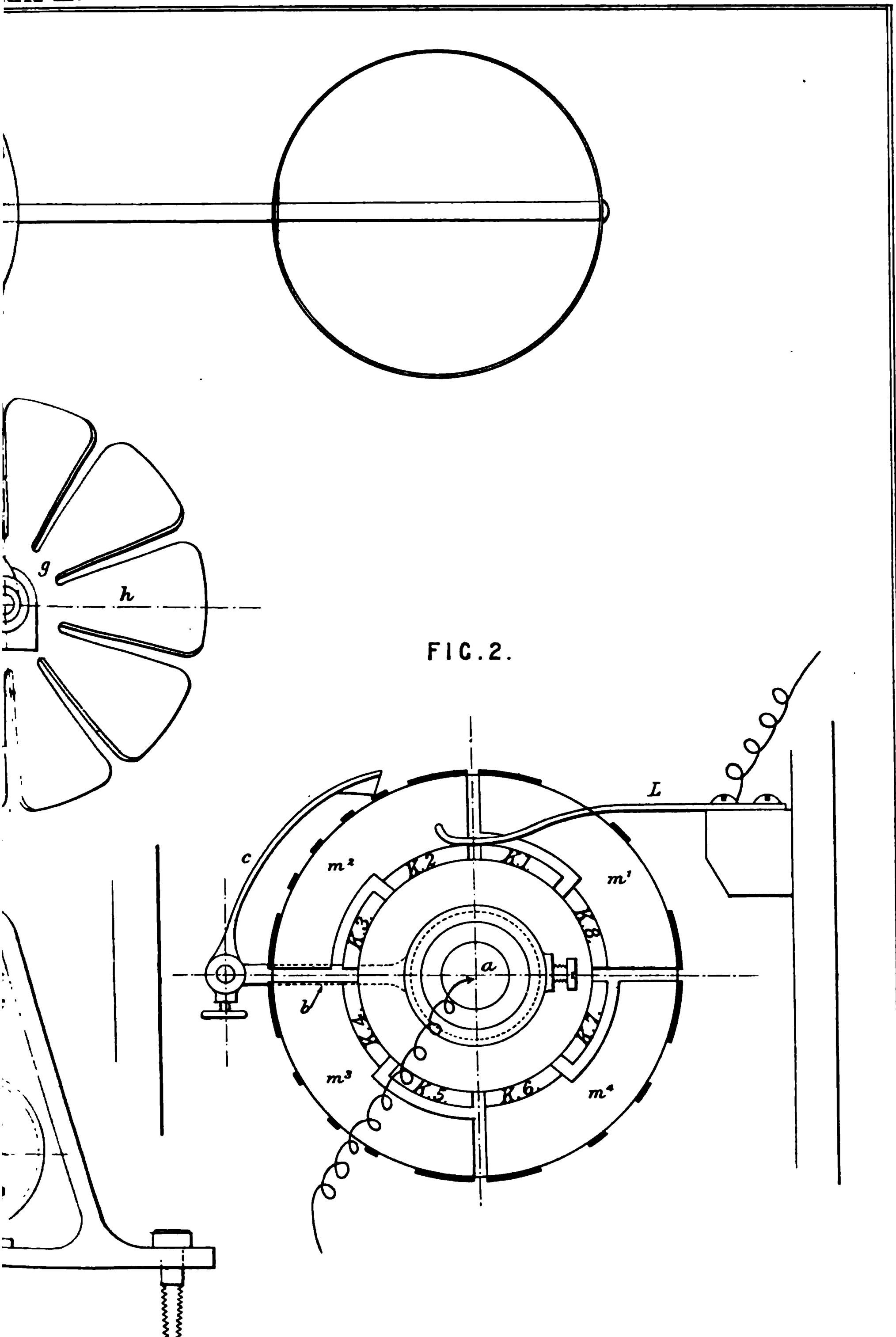
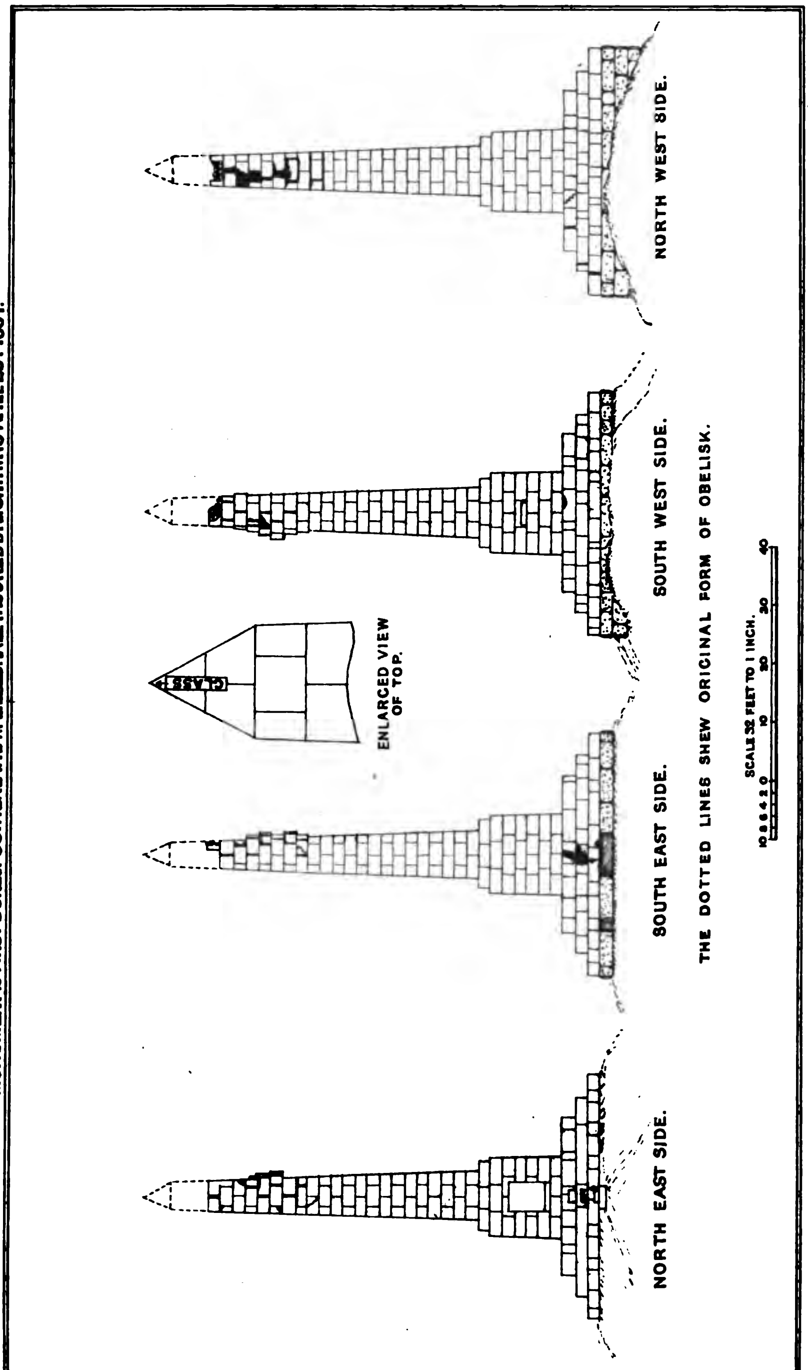


FIG. 2.

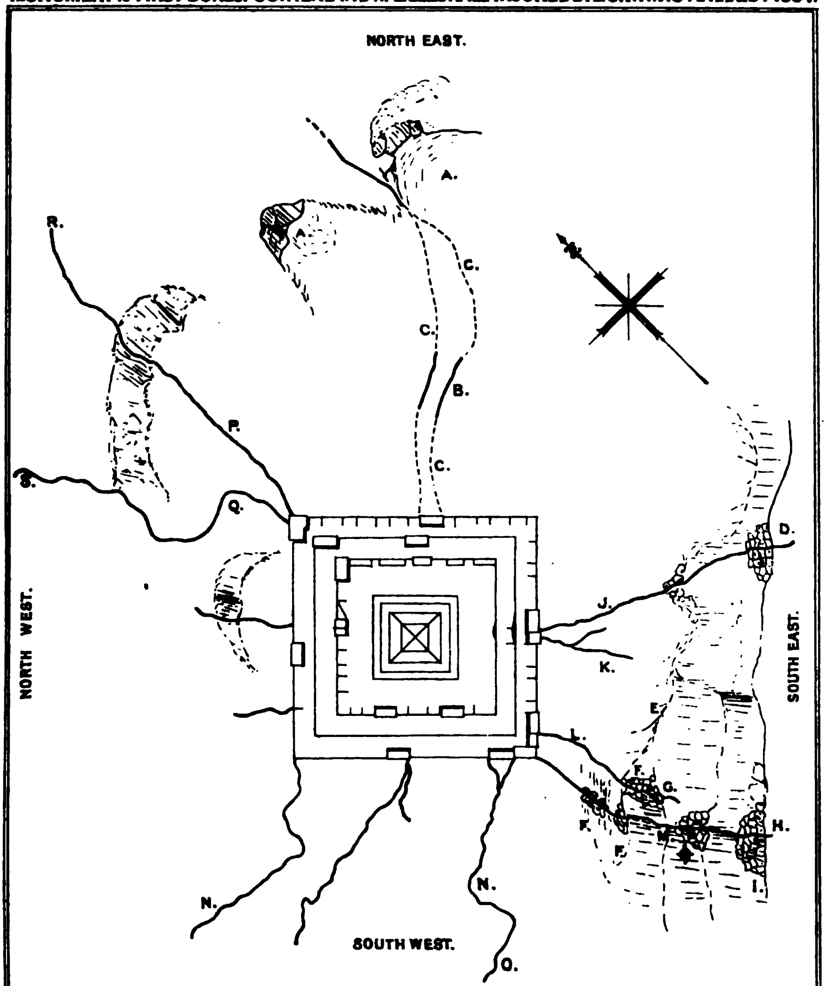
Malby & Sons, Lith.

MONUMENT TO FIRST DUKE OF SUTHERLAND AT LILLESHALL INJURED BY LIGHTNING APRIL 26TH 1884.



Malby & Sons, Lith.

MONUMENT TO FIRST DUKE OF SUTHERLAND AT LILLESHALL INJURED BY LIGHTNING APRIL 28TH 1884.



REFERENCES.

A. BARE ROCKS.
B. ELECTRIC CURRENT PASSED UNDERNEATH HERE FOR A LENGTH OF 18 INCHES & LOOSENED TURF.
C. DOTTED LINES SHEW PROBABLE COURSE OF ELECTRIC CURRENT.
D. BROKEN DOWN ROCK 20 FEET BELOW BASE OF MONUMENT.
E. 5 FEET BELOW LEVEL OF BASE.
F. BROKEN UP ROCK.
G. ABOUT 25 FEET BELOW BASE OF MONUMENT.
H. DISAPPEARED IN EARTH, ABOUT 50 FEET BELOW BASE OF MONUMENT.
I. HEAP OF BROKEN ROCK FROM ABOVE. ✦
J. GROOVE 4" TO 5" WIDE & 3" TO 5" DEEP.
K. GROOVE 3" TO 4" WIDE & 3" TO 4" DEEP.
L. GROOVE 2" TO 3" WIDE & 3" DEEP.
M. GROOVE 6" WIDE & 6" DEEP.
N. GROOVES 3" TO 4" WIDE.
O. TRACK OF CURRENT FINISHES AT SURFACE.
P. GROOVE 4" TO 6" WIDE & 5" DEEP.
Q. GROOVE 4" TO 6" WIDE & 6" DEEP.
R. GROOVE 2" TO 3" WIDE, 16 FEET BELOW BASE OF MONUMENT.
S. GROOVE 2" TO 3" WIDE, CUTTING TURF.

SCALE 32 FEET TO 1 INCH

10 8 6 4 2 0 10 20 30 40

Malby & Sons, Lith.

Quarterly Journal

OF THE

ROYAL METEOROLOGICAL SOCIETY.

EDITED BY A

COMMITTEE OF THE COUNCIL.

APRIL 1885.

VOL. XI. No. 54.

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Price Five Shillings.

CONTENTS.

Royal Meteorological Society.

Established 1850. Incorporated by Royal Charter, 1866.

Office:—30 GREAT GEORGE STREET, WESTMINSTER, S.W.

SESSION 1885.

DATES OF MEETINGS.

January*	21	May	20
February	18	June	17
March	18	November	18
April	15	December	16

* Annual General Meeting.

The Chair will be taken at 7 p.m.

By permission of the Council of the Institution of Civil Engineers, the above Meetings will be held at 25 Great George Street, Westminster, S.W.

QUARTERLY JOURNAL

OF THE

ROYAL METEOROLOGICAL SOCIETY.

VOL. XI. APRIL 1885. No. 54.

REPORT OF THE COUNCIL

FOR THE YEAR 1884.

IN the Report for the year 1883 the Council dwelt at some length upon the changes necessary for the continued well-being of the Society, including certain alterations in the By-Laws, rendered desirable by the proposed increase in the subscriptions. They then pointed out the necessity for raising the annual subscription from £1 to £2 for all Fellows who had been elected since January 11th, 1870. They have now to congratulate the Society on a materially increased income, and the consequent continuance of its work and usefulness, which must otherwise have been curtailed by the want of funds. The number of Fellows who have resigned is but small, whilst the increase from the introduction of new Fellows compares favourably with former years, and the balance-sheet shows that the action of the Society in increasing the subscription was prudent.

The Council also desire to notice the success attending the Commemoration Dinner on June 17th, which was the first meeting of the kind since the foundation of the Society; and they trust that at some not very distant time a similar gathering will be held.

The Committees appointed to assist the Council in their work for this year were :—

GENERAL PURPOSES COMMITTEE :—The President, Secretaries, Foreign

Secretary, Treasurer, Mr. Ellis, Mr. Baldwin Latham, Mr. Laughton, and Mr. Lecky.

EDITING COMMITTEE :—The President, Mr. Inwards, Dr. Marcet, and Mr. Whipple.

EXHIBITION COMMITTEE :—The President, Secretaries, Mr. Laughton, Mr. Lecky, Mr. Strachan, and Mr. Whipple.

INTERNATIONAL HEALTH EXHIBITION COMMITTEE :—The President, Secretaries, Mr. Lecky, and Dr. Marcet.

DECREASE IN WATER SUPPLY COMMITTEE :—The President, Mr. Chatterton, Mr. Baldwin Latham, and Mr. Symons.

EXPERIMENTAL RESEARCH COMMITTEE :—The President, Mr. Abercromby, Prof. Archibald, Mr. Eaton, Dr. Gilbert, Mr. Laughton, Mr. Rollo Russell, and Mr. Symons.

COMMITTEE ON RECENT SUNRISES AND SUNSETS :—The President, Mr. Abercromby, Prof. Archibald, and Mr. Rollo Russell.

At the request of the Executive Council of the International Health Exhibition, the Council equipped a typical Climatological Station in the grounds of the Exhibition, in order that persons desirous of organising a station might see one arranged in accordance with the regulations of the Society. The enclosure was too small, and the instruments consequently too crowded; the exigencies of the Exhibition not permitting of more space being granted. The Executive Council of the Exhibition engaged an observer to take readings daily, at 9 a.m. and 8 p.m. (which were printed in the Official Programme), and to be in regular attendance to show the instruments to such visitors as might wish to examine them closely. The Council are pleased to report that the Station attracted much attention, and that the observer was the means of affording valuable information to numerous visitors. The pamphlet "*Memorandum on Climatological Observations and their relation to Public Health*" was freely distributed, and was much appreciatod. The Council also exhibited a number of large diagrams illustrative of climatic conditions prevailing in various parts of the world.

The Executive Council of the Exhibition are willing that the Climatological Station shall form a feature of the International Inventions Exhibition of 1885, and have arranged that the observations shall be carried on during the interval between the two Exhibitions.

At the request of the Executive Council of the Health Exhibition the Council of this Society arranged for a Conference on Meteorology in relation to Health, which was held at the Exhibition on July 17th and 18th. The attendance on both occasions was good, and the discussion on the papers well sustained. The Papers, together with the Discussion, were published in Vol. XI. of the *Health Exhibition Literature*, and have been reprinted in the *Quarterly Journal*, Vol. X. p. 275.

The inspection of the Society's Stations has been carried on as usual. Some of the northern stations were inspected by Mr. Symons, and those in the South of England were visited and the instruments used therein carefully compared by the Assistant Secretary, who reported that they were generally

in a satisfactory state. The number of thermometers tested (205) was larger than usual, and their index errors were found, with few exceptions, to have remained constant. The greatest changes, as might have been expected, occurred in new thermometers, which had evidently been graduated soon after the tubes were filled; and spirit was found at the top of the tube in a few of the minimum thermometers. In two or three cases the minimum thermometers probably gave erroneous readings, owing to the shifting of their indices from the shaking caused by the wind, &c. in consequence of the screens not having been firmly fixed, so that the Council recommend observers to pay more attention to the stability of their screens.

The Council having purchased a photographic apparatus, requested Mr. Marriott to take photographs of the stations. This has been successfully done, and the resulting views are a useful supplement to the old method of plans of the position of the instruments and of the surrounding houses and trees. The photographs have been mounted in an album, which can be seen at the Society's rooms.

In connection with the inspection of the Stations, the Council have much pleasure in stating that they have succeeded in reorganising that at Dartmoor. They trust that as the Medical Officer has promised to take the observations regularly, and to instruct a deputy, there will be no more gaps in the records of this important station.

The whole of Mr. Marriott's report on the inspection of the stations will be found in Appendix I. (p. 78.)

The Council are again indebted to the Rev. T. A. Preston for superintending the Phenological Observations and drawing up the Report thereof for the past year. (See p. 47.)

The subject of the brilliant sunrises and sunsets first observed in the autumn of 1883 was discussed by the Council, and a Committee, consisting of Messrs. Abercromby, Archibald, and Rollo Russell, was appointed to investigate it. This Committee issued a Circular, requesting from observers in various parts of the world short memoranda—

(1) As to whether any unusual appearances had been seen at sunrise or sunset;

(2) If so, when they began; and

(3) Any particulars which may have attracted attention.

To this circular several replies were received, but they were not sufficiently numerous to justify the drawing of conclusions, and the Committee proceeded to supplement them by extracts from various publications. The Royal Society, at a date subsequent to the appointment of the above Committee, nominated a Committee of their own to examine the entire question of the eruption of Krakatoa and the attendant phenomena, and as the Royal Society Committee had collected a large mass of information bearing on the sky coloration above mentioned, the Committee of this Society gladly accepted the invitation conveyed to them in the month of October, that its members should be co-opted into the Royal Society Committee, and that they should undertake the discussion of the entire mass of material bearing

on that branch of the subject. The Council have to regret that the state of Mr. Abercromby's health has precluded his taking part in the discussion hitherto.

The attention of the Council having been directed to the local phenomenon known as the Helm Wind of Cross Fell, Cumberland, they appointed a Committee, consisting of the President, Secretaries, Prof. Archibald, Mr. C. Harding and Mr. Whipple, who considered the subject of sufficient importance to organise a series of observations with a view to its elucidation. They reported that before recommending the establishment of a station with self-recording instruments on Cross Fell a circular letter should be inserted in the Penrith newspapers, calling attention to the subject, and inviting the contribution of records of past dates of Helm Winds and simple observations of various kinds in future. A circular letter has consequently been prepared, and sent to the Local Press, inviting not only records, but also sketches and photographs of the cloud formations. Blank forms have been prepared, and will be supplied gratuitously by Mr. T. G. Benn, F.R.Met.Soc., of Newton Reigny, Penrith, who has kindly undertaken to act as local superintendent for the Society in this investigation.

The Fifth Annual Exhibition of Instruments, which was held on March 19th, was devoted specially to Thermometers, and was of a very interesting character. On the same evening the President read a paper on the History of Thermometers. A complete list of the exhibits will be found in the *Quarterly Journal*, Vol. X. p. 196.

The Papers read during the year have been of the usual interest, and excited much attention and discussion. As some Papers of considerable length have been read in full at the meetings, and as the number of Papers sent in for reading has increased, it was deemed advisable that in the case of long Papers only such portions as were of special interest should be read, the time occupied being limited to twenty minutes. It was also resolved that in the discussions, no one, except by special permission of the chairman, should speak for a longer period than five minutes.

As the annual subscription has been increased it was decided, after due consideration, that the price of the *Quarterly Journal* should be fixed at 5s. each number, and that the *Meteorological Record* should be charged 1s. 6d. for each number, making a total of £1 6s. a year for the Society's publications.

The Library increases in value every year, not only by the additions of the publications of other Societies, which are received in exchange, but also by donations and the purchase of books and manuscripts. Amongst the donations received the Council desire to mention specially the bequest of the late Mr. Charles Greaves (*Past President*), which consisted of over one hundred volumes, many of which are somewhat rare. A list of these is given in Appendix IV. (p. 91). The Executive Council of the International Health Exhibition has presented to the Society a set of the Literature published in connection with the Exhibition. The Society has also obtained by purchase the MS. of Mr. Plant's Journals, kept in the neighbourhood of Birmingham

from November 1860 to August 1883; of that kept by Mr. Swanwick at Derby from July 1798 to November 1838; and of that kept in Edinburgh by Mr. J. McFarlane from January 1811 to June 1819.

The Society has to deplore the loss by death of one of its Honorary Members, Capt. N. Hoffmeyer, elected April 17th, 1878; and of nine Fellows:—Dr. Charles Barham, elected June 15th, 1864; Dr. Thomas Bridge Bott, elected January 20th, 1875; Rev. Charles Clinton Chevallier, M.A., elected December 20th, 1876; Dr. Fleetwood Churchill, elected February 17th, 1864; Stephen Cushing, elected February 15th, 1882; James Eldridge, Assoc.M.Inst.C.E., elected May 17th, 1876; Henry Batson Joyner, M.Inst. C.E., F.R.G.S., elected January 15th, 1879; Rev. Frederick Silver, M.A., F.L.S., F.G.S., F.R.A.S., F.R.G.S., elected March 19th, 1862; John Whitfield, M.Inst.C.E., elected January 18th, 1860; and George W. Wigner, F.C.S., F.I.C., elected December 17th, 1879.

The number of Life Fellows on the roll of the Society is 137, being an increase of six in the year; and of Ordinary Fellows 395, being a decrease of twenty-three; and there are nineteen Honorary Members, thus making a total of 551.

The following table exhibits the changes which have taken place in the number of Fellows during the year:—

Fellows.	Annual.	Life.	Honorary.	Total.
1883, December 31 ...	418	131	19	568
Since elected	+32	+ 4	+1	+37
Since compounded ...	− 5	+ 5	...	0
Deceased	− 7	− 3	−1	−11
Retired	−41	...	...	−41
Defaulters	− 1	...	...	− 1
Lapsed	− 1	...	...	− 1
1884, December 31 ...	395	137	19	551

The Balance Sheet (p. 86) shows the Society to be in a satisfactory position. It will be seen that the amount received for subscriptions during the year was £756 9s., which is £331 1s. in excess of that for the previous year, and that the life composition fees amounted to £135. Several Life Fellows have made donations to the Society of an equivalent to the difference between the old and new rates of composition; the sum thus realised was £45. The total receipts, including a balance of £244 3s. 5d. from 1883, amounted to £1,439 14s. 11d. The expenditure on the Journal was somewhat greater than usual,—the parts being larger, with more illustrations. The Meteorological Office, however, contributed the sum of £15 towards the cost of the Plates illustrating Mr. C. Harding's paper. The changes in the By-Laws and the alteration in the title of the Society have necessitated a considerable amount of printing, &c. The expenses in connection with the

exhibit at the International Health Exhibition and the printing of the pamphlet for distribution were £31 17s. 6d. The inspection of the stations cost £58 2s. 7d., while £12 12s. 4d. was paid for the photographic equipment and printing of pictures, and £13 10s. for meteorological instruments. The sum of £261 17s. 6d., the result of Life Compositions, was invested in Stock, thus making the total expenditure for the year £1,243 5s. 2d., and leaving a balance in hand of £196 9s. 9d.

When investing the Life Compositions the Council resolved to sell out some of the stock invested in the New 3 per Cents., and to purchase with the proceeds of the same and the amount to be invested £500 New South Wales Stock 4 per Cent. The Society's money now invested is as follows:—(1) £800, Manchester, Sheffield and Lincolnshire Railway 4½ Debenture Stock; (2) £500, New South Wales Stock 4 per Cent.; and (3) £168 6s. 8d., New 3 per Cents. The current value of these, as shown in the assets, is £1,684 11s. 5d.

APPENDIX I.

Report on the Inspection of the Stations during 1884.

The whole of the stations in the South of England have been inspected, and, with but few exceptions, have been found to be satisfactory. Special attention has again been given to the comparison of thermometers; the instruments at all the stations (with two exceptions) having been tested with the standards. In all, 205 thermometers have been tested. In the majority of cases the thermometers agreed with the former comparisons, but in some instances changes had taken place. The greatest changes occurred in new thermometers; that is, thermometers which had evidently been graduated soon after the tubes had been filled. Spirit was found at the top of the tube in a few of the minimum thermometers—in one case it amounted to 1°·2. Observers cannot be too careful in seeing that the index of the minimum thermometer when set agrees with the dry bulb reading, and also in watching for the first indication of spirit at the top of the tube.

In two or three cases, where the screen was not firmly fixed, or where the thermometers were not placed horizontally, the index of the minimum was liable to be displaced by shaking. In three instances also, the mercury in the maximum thermometer had a tendency to run up the tube and give too high a reading. At one station this was particularly the case, the thermometer evidently giving an uncertain reading.

At most of the stations the wet-bulb thermometer was in good working order, and had been properly attended to; at several, however, the muslin and conducting thread should be changed much more frequently than they have been. At two stations the muslin was very dirty, hard, and almost

dry. After fresh muslin and cotton had been put on at one of these places, the wet-bulb thermometer gave a reading 5° lower than previously. This clearly shows that great care and attention should be given by all observers to the working of the wet-bulb thermometer, otherwise the readings will not be correct.

The thermometer screens should be painted *white* regularly once each year, as this not only preserves the wood and prevents it getting unduly heated, but also induces cleanliness inside the screen. Those observers who have their screens regularly painted generally keep their thermometers clean and the wet bulb in good order.

At the request of the Council I have this year taken photographs of all the stations, and now beg to submit an album containing prints of the same. The photographs must not be looked upon from an artistic point of view, as they were taken in all sorts of weather, and sometimes under great difficulties. They, however, give a good idea of the exposure of the instruments and surroundings at the various stations. The observers have been greatly pleased with the proposal to photograph their stations, and have given me much assistance in carrying it out.

From the photographs it will be seen that the instruments at a few of the stations are very much enclosed by shrubs, &c. At Tunbridge, asparagus is allowed to grow up in the summer so that the tops surround the thermometers, and almost hide the rain gauge. At Hastings, where the screen is in a confined situation and overhung by a cherry-apple tree, the instruments will be moved to a more open situation. At Strathfield Turgiss the site originally selected for the exposure of the instruments is now much enclosed by fruit trees. It seems therefore desirable to recommend that the instruments be moved to an enclosure in the adjoining field on the 1st of January next.

On August 16th I went to Princetown and called upon the Governor of Dartmoor Prison, and inquired whether he could assist the Society in re-starting the Dartmoor station. He received me very kindly, and at once agreed to my request, and offered any site in the prison grounds that I might select. The Medical Officer, Dr. Watts, undertook to take the observations regularly at 9 a.m. and 9 p.m., and to forward the returns to the Society. Not being able to get the instruments formerly in use on Dartmoor, I ordered a set of thermometers, a rain-gauge, and Stevenson screen to be sent down from Mr. Casella. On August 27th, accompanied by Dr. Merrifield, I again went to Princetown, taking the barometer with me, and had the thermometer screen and rain-gauge placed on the lawn in front of the Infirmary, as shown in the photographs. The exposure is exceedingly good, and the observations, being under the control of the Governor, are likely to be continuous.

In conclusion I beg to recommend that for the future observers should be requested to have all their new instruments sent to the Society's office for approval before purchase. By this means unsatisfactory and defective instruments would be discarded, and greater accuracy and uniformity obtained. In support of this, it is only necessary to refer to the black bulb

solar thermometer *in vacuo*—several instruments which I have examined differing as much as 12° when placed side by side in the sun's rays.

If this privilege could be extended to all the Fellows of the Society, it would be a great boon, and would be the means of securing more reliable data than at present exist in many parts of the country.

WILLIAM MARRIOTT,
Assistant Secretary.

October 7th, 1884.

NOTES ON THE STATIONS.

ALSTON, *August* 18*th*.—The observer was absent, but was seen subsequently. The instruments were well placed and in good order, except that the rain gauge funnel was not fixed sufficiently firmly, and that spring water had been (temporarily) used for the hygrometer, as there was a slight deposit on the muslin. A new coating was put on, and the importance of using only rain water was pointed out. *Observer*, T. W. DICKINSON. (Inspected by Mr. Symons.)

ASHBURTON, *August* 26*th*.—Mr. Amery was away from home at the time of my visit, but the observations were being taken by the housekeeper. The instruments were in good order, but the muslin on the wet-bulb thermometer should be changed more frequently. The thermometer screen required painting and also one of the posts fastening.—*Observer*, F. AMERY, J.P.

BABBACOMBE, *August* 23*rd*.—This station was in a satisfactory condition; the thermometer screen, however, required painting.—*Observer*, E. E. GLYDE, F.R.Met.Soc.

BEDDINGTON, *September* 19*th*.—All the instruments were in good order. The observer was requested to remove a tree which shaded the solar thermometer in the afternoon, and also to keep the tree to the south of the rain-gauge cut low.—*Observer*, S. ROSTRON, F.R.Met.Soc.

BRAMPFORD SPEKE, *August* 21*st*.—The instruments were in the same position as at the last inspection, the thermometers being on a wall screen fixed to a garden wall with a north aspect. On comparing the thermometers it was found that the zeros of both dry and wet had risen 0°·2. As the rim of the rain-gauge was defective the observer was requested to start a new one in the garden, where there will be a good exposure.—*Observer*, W. H. GAMLEN.

BRIDGETOWN, *August* 26*th*.—The screen was moved to the south side of the lawn on January 1st, 1883. The thermometers were all in good order, and the station in a satisfactory condition.—*Observer*, T. H. EDMONDS.

BUDE, *August* 19*th*.—The instruments are in the same position as formerly. As the index of the minimum thermometer seemed liable to be shaken down in windy weather, the observer was requested to mount the instrument quite horizontally, to add inner louvres to the screen, and also to re-arrange the position of the thermometers. It is probable that the screen will very shortly be moved to a better situation.—*Observer*, J. ARTHUR.

CHELTENHAM, *August* 29*th*.—The observer was away from home at the time

of my visit. On comparing the thermometers it was found that both the minimum and grass-minimum read too low, having spirit at the top of the tube. The covering of the wet-bulb thermometer was very dirty and hard, and should be changed more frequently. The screen also required painting. As several of the trees in the neighbourhood subtended a considerable angle at the rain-gauge, the observer was subsequently requested to have their tops cut off.—*Observer*, R. TYRER, B.A., F.R.Met.Soc.

CROYDON, *September* 19*th*.—Every thing was in good order. As Mr. Mawley will shortly remove from Croydon the second order observations will be discontinued on December 31st.—*Observer*, E. MAWLEY, F.R.Met.Soc.

CULLOMPTON, *August* 21*st*.—All the instruments were in good order. The trees to the West and West-north-west may possibly intercept the sun's rays in the evening from the sunshine recorder, if so it will only be for a short time.—*Observer*, T. TURNER, J.P., F.R.Met.Soc.

FALMOUTH, *August* 13*th*.—On June 21st, 1888, the thermometers were removed to Mr. Fox's new house, Carmino, which has a large garden, so that the exposure is very good and open. The rain-gauge, however, remains in the same garden as formerly, and is read at 10 a.m. by the Observatory staff. On comparing the thermometers it was found that the dry and wet had risen 0°·2. The observer was requested to rearrange the thermometers and also to lay down more grass round the screen.—*Observer*, W. L. FOX, F.R.Met.Soc.

FINCHLEY, *September* 18*th*.—The works which were in progress at the time of the last inspection (1881) are not yet completed. A good deal of soil had been thrown up near the thermometer screen (as shown in the photograph), but I was informed that this had only been the case for a fortnight. The screen urgently required painting. A sloping upper roof had been added like in the new pattern screen, but the wood had not been painted. The muslin on the wet bulb was very dirty. A fresh site was selected for the instruments in a field where the exposure is very open.—*Observer*, H. C. STEPHENS, F.R.Met.Soc.

GUERNSEY, *July* 24*th*.—Both the maximum and minimum thermometers were on the slant and not firmly fixed, and required to be mounted horizontally and securely fastened. On comparing the thermometers it was found that the maximum, which is graduated from − 50° to + 150°, read 1°·1 too high.—*Observer*, Dr. F. E. CAREY, F.R.Met.Soc.

HARESTOCK, *July* 30*th*.—Every thing at this station was in a satisfactory condition.—*Observer*, LIEUT.-COL. H. S. KNIGHT, F.R.Met.Soc.

HASTINGS, *September* 12*th*.—The observations at the Infirmary were discontinued on December 31st, 1888, since which time Mr. Wood has furnished observations from the Hollies. This is about a mile East of the former site and 110 feet above sea level, and the ground slopes considerably from North to South. The thermometer screen is a double one and very firmly fixed; it is, however, in a very confined situation, and is overhung by a cherry-apple tree. The maximum thermometer was slightly inclined with the top downwards, so that the mercury had a tendency to creep up the tube. The water vessel was directly under the wet bulb. The rain gauge is placed 3 ft. 6 ins.

above the ground in a gas main pipe filled with earth. As the gauge was an old one it was recommended that a new 5 inch Snowdon gauge be started on an adjoining plot of ground 1 ft. above the soil. Also that the thermometer screen should be brought down to the same place, and that a square plot of grass should be laid down.—*Observer*, A. H. Wood, F.R.Met.Soc.

Helston, *August 14th.*—The observer was again away at the time of my visit, but I had an opportunity of examining the instruments. The dry and wet bulb thermometers were placed at the back of the screen, and the maximum and minimum on two uprights in front, the maximum being at the top and the minimum at the bottom. The mercury in the maximum ran up the tube whenever the screen was shaken, and consequently would give too high a reading in windy weather if not carefully manipulated. I altered its position by placing it near the minimum and inclining the tube slightly upwards. The minimum had 1°·2 of spirit near the top of the tube, which I dislodged after comparison with the standards.—*Observer*, J. Gill.

Ilfracombe, *August 20th.*—The instruments were in the same position as formerly, and the thermometers agreed with the previous comparison. The observer was requested to move the maximum to the other side of the barometer, and to have holes cut in the board behind the backs of the maximum and minimum, and to employ a better water receptacle for the wet bulb.—*Observer*, M. W. Tattam.

Isleworth, *September 5th.*—This station was in good order. On comparing the thermometers it was found that the zeros of the dry and wet had risen 0°·3 and 0°·6 respectively.—*Observer*, Miss E. A. Ormerod, F.R.Met.Soc.

Maker, *August 10th.*—Since the last inspection the inner roof of the screen had been taken out in order to secure better circulation. All the instruments were in good condition.—*Observer*, Rev. P. H. Newnham, M.A., F.R.Met.Soc.

Margate, *September 10th.*—This station was in a satisfactory condition and the instruments in good order.—*Observer*, J. Stokes, F.R.Met.Soc.

Marlborough, *August 30th.*—Since the last inspection (1880) a sunshine recorder and a set of earth thermometers at 6 ins., 1 ft., 1½ ft., and 2 ft. have been added to the equipment of the station. All the instruments were in a satisfactory condition except the wet bulb, the muslin on which was somewhat dirty.—*Observer*, Rev. T. A. Preston, M.A., F.R.Met.Soc.

Newton Reigny, Penrith, *August 16th.*—The instruments are in a small but well-exposed grass enclosure in the rear of the house—all appeared to be in good order. The sunshine recorder is fixed on a tall and stout wooden stand, and the exposure is perfect. The observer has a self-recording (Richard) barograph, and is daily expecting a thermograph from the same firm.—*Observer*, T. G. Benn, F.R.Met.Soc. (Inspected by Mr. Symons.)

Old Street, E.C. (St. Luke's), *September 23rd.*—The thermometers were found to be correct except the minimum, which had 0°·2 of spirit at the top of the tube. As smoke and dust are very prevalent in this neighbourhood orders were given for the screen to be painted twice a year. The observer had hitherto reported the direction of the wind as magnetic instead of true. —*Observer*, Rev. A. P. Hockin.

PORTSMOUTH, *July 29th.*—The observer was requested to have two uprights inserted in the screen on which to mount the maximum and minimum which are now placed at the back, and also to have the screen painted. The deputy observer appeared to under-estimate the amount of cloud.—*Observer*, R. E. POWER, L.R.C.P.

PRINCETOWN, DARTMOOR, *August 27th-28th.*—This station has been re-organised, and with the consent of the Governor, the instruments are placed on the lawn in front of the Prison Infirmary. The observations were commenced by Dr. T. F. Watts, who unfortunately died in October, since which time they have been continued by his colleague.—*Observer*, DR. V. N. BINDLEY.

RAMSGATE, *September 11th.*—The instruments were in good order. The observer was requested to have the dry and wet raised a little, and the water receptacle lowered, and also to have the top cut off a pear tree to the North-west, as it made a considerable angle with the rain-gauge.—*Observer*, M. JACKSON, F.R.Met.Soc.

REGENT'S PARK, *September 18th.*—This station was not in a satisfactory condition. The muslin on the wet bulb was very dirty; after I had put on fresh muslin the wet bulb read 5° lower than previously. On comparing the thermometers it was found that the maximum read 0°·6 too low, and that the minimum had some spirit at the top of the tube. On inquiry I found that the minimum was set (but not read) at 8 p.m., so that the reading at 9 a.m. did not refer to the whole of the previous twenty-four hours; and that the maximum was read and set at 9 p.m. and not at 9 a.m. It also appeared that the corrections for index error had not been applied to any of the readings of the thermometers. The screen, which was rather dirty, required to be painted *white.*—*Observer*, W. SOWERBY, F.R.Met.Soc.

SCALEBY HALL, *August 19th.*—The rain-gauge was not quite firm, and the wet bulb thermometer was dry, owing to the conducting thread being too small and of too close a texture. This was put right, and the observer shown how to keep it so. All other instruments and arrangements perfectly satisfactory.—*Observer*, R. A. ALLISON, F.R.Met.Soc. (Inspected by Mr. Symons.)

SKATHWAITE, *August 9th.*—The observer was absent, but the record was very neatly kept, and instruments were all in excellent order, quite clean, and the muslin of the hygrometer in good condition. The brass mountings of one thermometer were being corroded by damp, and one of those of another was broken, but the tube was firmly held by its second. It would be well if opticians could be induced to employ only one pattern of mounting and of screw for standard instruments, as then fresh ones could be put on either by the inspectors or by the observers.—*Observer*, W. DIXON. (Inspected by Mr. Symons.)

SIDMOUTH, *August 28th.*—Every thing was in good order. A large tree to the South-west of the rain-gauge had been blown down since the last inspection, the exposure from that quarter being consequently more open.—*Observer*, DR. W. T. RADFORD, F.R.Met.Soc.

SOUTHAMPTON, *July 22nd.*—This station was in good order. Several trees and bushes have been cut down since the last inspection, so that the exposure is more open.—*Observer*, REV. H. GARRETT, M.A., F.R.Met.Soc.

SOUTHBOURNE-ON-SEA, *July 23rd.*—This station was in a satisfactory condition. Dr. Compton is of opinion that the sunshine recorder gets out of focus by the evening, and consequently does not register a sufficient amount of sunshine.—*Observer*, DR. T. A. COMPTON, F.R.Met.Soc.

SOUTHEND, *September 16th.*—All the instruments were in good order except the maximum, which was not working satisfactorily. The mercury seemed to run up the tube and give too high a reading.—*Observer*, G. LINGWOOD.

SOUTH NORWOOD, *September 19th.*—On comparing the thermometers they were all found to be correct. A second rain-gauge had been started a few months previously at the bottom of the slope on which stand the other instruments. The results showed that the lower gauge collected slightly more rain than the upper one.—*Observer*, W. F. STANLEY, F.R.Met.Soc.

STOWELL, *August 11th.*—The instruments are placed on a lawn in a garden well exposed and open. The ground rises on the North-east, but otherwise it is moderately level. The district, however, is somewhat undulating. The screen is a large home-made one. The observations appeared to be taken in a satisfactory manner.—*Observer*, REV. H. J. POOLE, F.R.Met.Soc.

STRATHFIELD TURGISS, *July 21st.*—On comparing the thermometers it was found that the maximum, minimum and grass minimum had altered somewhat since the last inspection (1880). During the summer, when the shrubs are numerous and full grown, the exposure is confined. It is therefore desirable that the instruments should be removed to an enclosure in the adjoining field on January 1st, 1885. Owing to various causes the Rev. C. H. Griffith will not be able to continue the second order observations after this month, but will furnish climatological observations instead.—*Observer*, REV. C. H. GRIFFITH, F.R.Met.Soc.

SWANAGE, *July 23rd.*—I found that Dr. Jumeaux had left Swanage, and that the observations had been discontinued at the end of June. Mr. Andrews, who had acted as joint observer with Dr. Jumeaux, had ceased observing in January, as the station was a considerable distance from his house. The instruments had been handed over to another gentleman, but the observations did not appear to have been regularly made.

SWARRATON, *July 30th.*—All the instruments were in good order.—*Observer*, REV. W. L. W. EYRE, M.A., F.R.Met.Soc.

TEIGNMOUTH (BITTON), *August 22nd.*—On comparing the thermometers it was found that the zero of the wet bulb had decreased $0^{\circ}\cdot 4$. This thermometer was subsequently sent to Kew for re-verification, but was broken in transit. The thermometer screen required painting.—*Observer*, DR. W. C. LAKE.

TEIGNMOUTH (WOODWAY), *August 23rd.*—This station was in a satisfactory condition. The observer undertook to have the screen painted white instead of oak grained.—*Observer*, G. W. ORMEROD, M.A., F.R.Met.Soc.

TORQUAY, *August 25th.*—The observer was away from home at the time of

my visit, but the gardener was in charge of the observations. He, however, only read the thermometers to half-degrees. On comparing the thermometers it was found that all their zeros had changed. The screen required painting.—*Observer*, C. J. Harland.

Tunbridge, *September 12th*.—The observer was away for his holiday, and, as he has no deputy, no observations were being made. Most of the instruments had been removed, and consequently could not be tested. The exposure was unsatisfactory, as the asparagus is allowed to grow to such an extent that the tops surround the thermometer screen and almost hide the rain-gauge.—*Observer*, W. C. Punnett, F.R.Met.Soc.

Tunbridge Wells, *September 12th*.—The instruments were all correct. The screen required painting. As lawn tennis is played near the instruments they will be removed to another situation on January 1st, 1885.—*Observer*, F. Green, M.A., F.R.Met.Soc.

Ventnor, *July 28th*.—All the instruments were in good order. The small mound to the North of the rain-gauge will be removed and the gauge placed 4 ft. further from the thermometer screen.—*Observer*, H. Sagar.

Weston-super-Mare, *August 29th*.—The thermometers were all correct except the minimum, which had some spirit at the top of the tube. The screen required painting, and also strengthening with additional stays, as it shakes during windy weather and causes the index of the minimum to go up with Westerly winds and go down with Easterly winds.—*Observer*, W. E. Perrett.

Weymouth, *July 26th*.—The instruments were in the same position as formerly. On comparing the thermometers it was found that the zeros of the dry and minimum had altered somewhat.—*Observer*, Serjeant J. Evans, R.E.

Worthing, *September 18th*.—This station was in good order. On comparing the thermometers it was found that the dry, wet, and maximum had increased by $0^{\circ}\cdot 2$, and that the minimum had $0^{\circ}\cdot 4$ of spirit at the top of the tube.—*Observer*, W. J. Harris, M.R.C.S., F.R.Met.Soc.

APPEN-

ABSTRACT OF RECEIPTS AND EXPENDITURE

RECEIPTS.

	£ s. d.	£ s. d.
Balance from 1883		244 3 5
Dividends—M. S. and L. R. 4½ Debenture Stock	35 5 0	
Do. N. S. W. Stock 4 per Cent.	9 15 10	
Do. New 3 per Cents.	10 19 11	
		56 0 9
Subscriptions for 1882	5 1 0	
Do. 1883	23 2 0	
Do. 1884	686 3 0	
Do. 1885	42 3 0	
Entrance Fees	40 0 0	
Life Compositions	135 0 0	
Donations by Life Fellows (Messrs. W. D. Howard, H. Mellish, H. Toynbee, J. P. H. Walker and F. Wilkin), &c.	45 0 0	
		976 9 0
Meteorological Office:—		
Copies of Monthly Returns (11 months)	91 13 4	
Do. Annual ,,	2 10 0	
Do. Weekly ,, including postage	5 0 10	
Grant towards Inspection expenses	25 0 0	
Do. ,, printing Mr. C. Harding's Paper	15 0 0	
		139 4 2
Sale of Publications		23 17 7
		£1439 14 11

DIX II.

FOR THE YEAR ENDING DECEMBER 31ST, 1884.

EXPENDITURE.

	£ s. d.	£ s. d.
Journal, &c.:—		
Quarterly Journal Nos. 49-52	155 12 6	
Illustrations	60 16 9	
Authors' Copies	12 13 6	
Meteorological Record, Nos. 11-14	54 6 9	
Registrar-General's Reports	8 8 0	
		291 17 6
Printing, &c.:—		
General Printing	31 12 3	
List of Fellows and By-Laws	20 2 6	
Forms	0 14 6	
Stationery	20 16 0	
Books and Bookbinding	34 18 0	
Stamped Receipt Books	12 15 0	
		120 18 3
Salaries:—		
Assistant-Secretary	175 0 0	
Computers	137 16 0	
		312 16 0
Office Expenses:—		
Rent and Housekeeper	48 7 0	
Furniture, Insurance and Coals	7 7 6	
Postage	47 10 9	
Refreshments at Meetings	13 8 3	
Thermometer Exhibition Expenses	1 3 8	
International Health Exhibition Expenses	31 17 6	
Parcels and Petty Expenses	9 10 6	
Subscriptions overpaid returned	5 0 0	
Commission on Scotch and Irish Cheques	0 3 10	
		164 9 0
Observations:—		
Inspection of Stations	58 2 7	
Photographic Equipment and Printing	12 12 4	
Observers at Old Street and Seathwaite	7 2 0	
Instruments	13 10 0	
		91 6 11
Stock:—		
Investment of Life Compositions, 1883-4		261 17 6
		1243 5 2
Balance:—		
At Bank of England	184 0 6	
In hands of the Assistant-Secretary	12 9 3	
		196 9 9
		£1439 14 11

Examined and compared with the vouchers and found correct.

12th January, 1885.

J. S. HARDING, } *Auditors.*
H. SOWERBY WALLIS, }

APPENDIX II.—*Continued.*

ABSTRACT OF ASSETS AND LIABILITIES, ON JANUARY 1ST, 1885.

LIABILITIES.

	£	s.	d.
To Subscriptions for 1885, paid in advance	42	8	0
" Excess[1] of Assets over Liabilities	2027	6	3
	£2069	9	3

[1] This excess is exclusive of the value of the Library and Stock of Publications.

ASSETS.

	£	s.	d.	£	s.	d.
By Society's Money invested in M. S. and L. R. 4½ Debenture Stock, £800 at 125	1000	0	0			
" Society's Money invested in N. S. W. Stock, 4 per cent. £500 at 103½	517	10	0			
" Society's Money invested in New 3 per Cents., £168 6s. 8d. at 99¼	167	1	5			
				1684	11	5
" Subscriptions unpaid, estimated at	35	0	0			
" Entrance Fees unpaid	3	0	0			
" Dividend on £800 M. S. and L. R. 4½ Debenture Stock	17	10	3			
" Do. £500 N. S. W. Stock, 4 per cent.	9	14	2			
" Meteorological Office—Weekly Returns, 1884	4	17	0			
" Do. Monthly " July 1884	8	6	8			
				78	8	1
" Furniture, Fittings, &c.	30	0	0			
" Instruments	80	0	0			
				110	0	0
" Cash in hands of Bank of England	184	0	6			
" Do. the Assistant-Secretary	12	9	3			
				196	9	9
				£2069	9	3

J. S. HARDING,
H. SOWERBY WALLIS, } *Auditors.*

WILLIAM MARRIOTT, *Assistant-Secretary.*

12th January, 1885.

APPENDIX III.

Obituary Notices.

Dr. Charles Barham was born at Truro Vean, on March 9th, 1804, and was educated at Bodmin and Downing College, and subsequently at Queen's College, Cambridge. He also studied at Edinburgh, Paris, and Bologna. He took the degree of M.B. in 1827, and M.D. (Cantab.) in 1860. Dr. Barham first commenced his regular practice as a physician in Plymouth, but left there for an appointment at the Tavistock Dispensary. He returned to Truro in 1832, where he remained and practised as a physician till the close of his life.

Dr. Barham held many various offices, and was greatly esteemed in Truro. He was elected Mayor in 1858.

In 1838, Dr. Barham, in conjunction with the late Mr. W. Mansil Tweedy, as joint Secretaries of the Royal Institution of Cornwall, and with the aid of Sir Charles Lemon, Sir R. R. Vyvyan, Mr. Davies Gilbert, and other gentlemen of Cornwall, revived and reorganised that Institution, and at an early meeting of the members in the same year gave an address on the importance of accurate observations of the weather in regard to temperature, barometric pressure, the direction and intensity of the wind, and the number of dry, wet, fine, and cloudy days, with a view of a just comparison of the county with the climate of other places. He urged that the central situation of Truro rendered it a most eligible site for a meteorological observatory, and urged that early steps should be taken to carry out this object. He pointed out the great equability of our climate, and contrasted the annual range of the thermometer with that of London and of the South of France. It was determined that the necessary instruments should be at once procured, and the observations taken by the Curator, under the superintendence of Dr. Barham, and the results given yearly in the Journal of the Institution.

During the last two years of his life, with great labour and zeal Dr. Barham reduced and tabulated the whole series of observations from 1840 to 1881 inclusive, which are now being published in a separate form by the Institution.

Dr. Barham took great interest in meteorology, and collected and discussed the observations made in various parts of Cornwall for the *Journal of the Royal Institution of Cornwall*. He also wrote a number of papers on meteorological subjects, which were chiefly published in the same Journal.

Dr. Barham died on October 18th, in the 80th year of his age.

In the early death of Captain Niels Hoffmeyer, which occurred at Copenhagen, on February 10th, modern Meteorology has lost one of its most zealous and successful students, and one whose place it will be hard to fill. Like several of our own physicists, Hoffmeyer was an artillery officer, and had attained the rank of Captain. At the close of the Prussian war he had fallen into bad health, and accordingly on the reduction of the Danish Army, which then took place, his name was removed from the active list, so that he was for a time unoccupied.

The Danish Meteorological Institute was established in 1872, and Capt.

Hoffmeyer was nominated as its first Director. There could scarcely have been a more fortunate appointment, as Capt. Hoffmeyer was gifted not only with unusual energy, but also with a very pleasant manner, so that he made friends for his Office and his work wherever he went.

He will best be known by his *Atlas*. He undertook to prepare daily weather charts of the Atlantic, practically as a private speculation of his own, and he actually published them for the period of 3½ years; and he had but just announced his intention to resume this work in combination with the Deutsche Seewarte, under Dr. Neumayer, when he was taken from us.

The most important results he had deduced from his own charts were contained in his pamphlet, *Etude sur les Tempêtes de l'Atlantique Septentrional et projet d'un Service Télégraphique International relatif à cet Ocean*, and up to the very last he never ceased to use his utmost efforts for the establishment of a meteorological telegraphic service with America, *viâ* the Faroes and Iceland.

While Hoffmeyer's chief work was done in the domain of Synoptic Meteorology, he by no means disregarded Climatology, and the service which the Danish Office has rendered to that science by the maintenance of stations in Iceland and Greenland has been very material.

When Capt. Hoffmeyer was in London in 1883, as Danish Commissioner of the International Fisheries Exhibition, he was complaining of great weakness of the heart, and during December he was laid by for some time. He had somewhat recovered, when he was seized with rheumatic fever, to which he fell a victim on February 10th.

He was elected an Honorary Member of this Society on April 17th, 1878. He was one of the Secretaries of the Meteorological Congress of Rome, 1879; and of the Conference on Maritime Meteorology in London, 1874; but his chief official service of this nature was as Secretary to the International Polar Commission, where his loss, coming after that of Weyprecht, will be severely felt.

Rev. Frederick Silver was born at St. John's Wood, in 1821. He received a private education in the early part of his life, afterwards proceeding to Worcester College, Oxford, where he graduated about the year 1846.

Soon after leaving Oxford he took holy orders, and eventually held the living of Norton-in-Hales, Market Drayton, where he was rector for more than thirty years.

Though laying claim to no high intellectual power, he was possessed of a kind and benevolent spirit, which he exercised for the benefit of those within his circle, and especially the humbler classes. At frequent intervals he gathered in his rectory grounds large numbers of the working classes from the neighbourhood for the purpose of lectures upon botanical, geological, and kindred subjects, and also to inspect the objects in his museum, the collection of which had occupied his attention for many years. He thus endeavoured to elevate the masses and foster an interest in things superior to their every day surroundings. He died at Norton, Market Drayton, on August 28th.

He was elected a Fellow of this Society on March 19th, 1862.

Mr. Silver was also for many years a Fellow of the Linnean, Royal Astronomical, Royal Geographical, and Geological Societies.

APPENDIX IV.

LIST OF BOOKS BEQUEATHED BY THE LATE MR. CHARLES GREAVES.

ADAMS, G.—Lectures on Natural and Experimental Philosophy. Second Edition. 5 vols. 8vo. (1799.)

AEOLUS.—A Circular Invitation to contribute to the History of the Weather. 8vo. (1844.)

ANSTED, PROF. D. T.—Water, and Water Supply. Surface Waters. 8vo. (1878.)

BATEMAN, DR. T.—Reports on the Diseases of London, and the state of the Weather, from 1804 to 1816. 8vo. (1819.)

BENNET, Dr. J. H.—Winter and Spring on the Shores of the Mediterranean. Fifth Edition. 8vo. (1875.)

BERGH, A.—On the Causes of distant alternate Periodic Inundations over the low lands of each Hemisphere. 8vo. (1830.)

BIRT, W. R.—Handbook of the Law of Storms. New Edition. 8vo. (1879.)

BROWN, DR. J. C.—Forests and Moisture. 8vo. (1877.)

——————Hydrology of South Africa. 8vo. (1875.)

——————Reboisement in France. Second issue. 8vo. (1880.)

CAUTLEY, COL. SIR P. F.—Ganges Canal. 8vo. (1864.)

CALDCLEUGH, A., F.R.S.—Account of the Great Earthquake in Chile, February 20th, 1875. 4to. (1836.)

CHAMBERS, F.—Diurnal Variations of the Wind and Barometric Pressure at Bombay. 4to. (1873.)

COLDING, A.—Miscellaneous Papers. 4to. (1867-72.)

COTTON, MAJOR-GEN. SIR A., AND CAUTLEY, COL. SIR P. F.—The Ganges Canal. 8vo. (1864.)

COTTON, MAJOR-GEN. SIR A.—Reply to Col. Sir P. Cautley's "Disquisition" on the Ganges Canal. 8vo. (1864.)

CROYDON.—Details of the terrible Storm in Croydon, June 23, 1878. 16mo. (1878.)

DALRYMPLE, DR. D.—Meteorological and Medical Observations on the Climate of Egypt. 12mo. (1861.)

DALTON, DR. J., F.R.S.—Meteorological Observations and Essays. Second Edition. 4to. (1834.)

DE LA RUE, DR. W., F.R.S., STEWART, B., F.R.S., AND LOEWY, B.—Researches on Solar Physics. First and Second Series and Appendix. 4to. (1865.)

ENCYCLOPÆDIA BRITANNICA, Part 9, Ninth Edition. 4to. (1875.)

ENCYCLOPÆDIA METROPOLITANA. Second Division. 4to. (1848.)

GENIEYS, M.—Essai sur les Moyens de Conduire, d'Elever et de Distribuer les Eaux. 4to. (1829.)

GRANTHAM, R. B.—Report on the Floods in Somersetshire in 1872-73. Foolscap Folio. (1873.)

GUARINI, G., PALMIERI, L., ED SCACCHI, A.—Memoria sullo Incendio Vesuviano del mese di Maggio, 1855. 4to. (1855.)

HARRIS, SIR W. SNOW.—Observations on the Effects of Lightning on Floating Bodies. 4to. (1823.)

HEAT AND COLD, Treatises on. By Dr. E. Darwin, Rev. J. Farquharson, G. Fordyce, C. Hatchett, W. Herschel, Sir E. Home, Dr. J. Hunter, Dr. A. Marcet, P. Prevost, J. Six, Sir B. Thompson, R. Walker, and others.

HEAT, Treatises on. By W. Herschel, M. Lavoisier, M. de la Place, and others. (2 vols.)

HENNESSY, PROF. H., F.R.S.—On the Distribution of Temperature in the lower region of the Earth's atmosphere. 4to. (1867.)

INDIA.—Abstract of the Results of the Hourly Meteorological Observations taken at the Surveyor-General's Office, Calcutta, 1868. 8vo. (1868-9.)

INDIA.—Report on the Meteorology of the Punjab, 1870. Foolscap Folio. (1871.)

INDIA.—North Western Provinces.—Report on Meteorological Observations, 1872-4. Foolscap Folio. (1873-5.)

JEFFRIES, DR. J.—A Narrative of the two Aerial Voyages of Dr. Jeffries with Mons. Blanchard. 4to. (1786.)

JONES, J. M.—The Naturalist in Bermuda. 8vo. (1859.)

KOPP, H.—Einiges über Witterungsangaben. 8vo. (1879.)

KREYSIG, DR. F.—A Treatise on the Use of the natural and factitious Waters of Carlsbad, Ems, Marienbad, &c., Pt. II., 8vo. (1824.)

LAVOISIER, M.—Essays on the Effects produced by various Processes on Atmospheric Air. Translated from the French by T. Henry, F.R.S. 8vo. (1783.)

LAVOISIER, M.—Essays Physical and Chemical. Vol. I. Translated from the French by T. Henry, F.R.S. 8vo. (1776.)

LEE, DR. E.—Spain and its Climates. (Re-issued) 12mo. (1860.)

LIBRARY OF USEFUL KNOWLEDGE. Natural Philosophy. Parts I. and II. 8vo. (1829-32.)

LLOYD, REV. DR. H.—Notes on the Meteorology of Ireland. 4to. (1854.)

LOOMIS, PROF. E.—On two Storms which were experienced throughout the United States, February 1842. 4to. (1846.)

MALLET, R., F.R.S.—Account of Experiments made at Holyhead (North Wales) to ascertain the Transit-Velocity of Waves, analogous to Earthquake Waves, through the Local Rock Formations. 4to. (1861.)

NARES, CAPT. G. S.—The Official Report of the Recent Arctic Expedition. 8vo. (1876.)

PECLET, PROF. E.—Nouveaux Documents relatifs au Chauffage et à la Ventilation des Etablissements Publics. 4to? (1854.)

PECLET, PROF. E.—Traité de la Chaleur. Troisième Edition. 8vo? (1844.)

PIDDINGTON, H.—Conversations about Hurricanes. 8vo. (1852.)

——————The Horn Book of Storms for the Indian and China Seas. 8vo. (1844.)

POTTS, T.—Gazetteer of England and Wales. 8vo. (1810.)

PRIESTLEY, J.—Historical Account of the Navigable Rivers, Canals, and Railways, throughout Great Britain. 4to. (1831.)

RAVENSTEIN, E. G.—The Oarsman's and Angler's Map of the River Thames.

REID, LIEUT.-COL. W., F.R.S.—An Attempt to develop the Law of Storms. Third Edition. 8vo. (1850.)

RENNELL, MAJOR J., F.R.S.—An Investigation of the Currents of the Atlantic Ocean. Three Vols. 8vo. (1832.)

SCORESBY, REV. W.—Description of some remarkable Atmospheric Reflections and Refractions observed in the Greenland Sea. 4to. (1822.)

SCORESBY, REV. W.—Observations on the Errors in the Sea Rates of Chronometers. 4to. (1822.)

SLADE, H. P.—A Short Practical Treatise on Dew Ponds. 8vo. (1877.)

SMITH, LIEUT.-COL. R. B.—The Cauvery, Kistnah, and Godavery. 8vo. (1856.)

SMITHSONIAN INSTITUTION.—On Certain Storms in Europe and America, December 1836. By Prof. E. Loomis. 4to. (1859.)

SMITHSONIAN INSTITUTION.—On Fluctuations of Level in the North American Lakes. By C. Whittlesey. 4to. (1859.)

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Birmingham.—Monthly Meteorological Reports of Observations made at the Philosophical Institution, 1841 to 1845. 8vo. (1841-5.)

Blodget, L.—Climatology of the United States. 8vo. (1857.)

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Philadelphia, Girard College.—Observations at the Magnetic and Meteorological Observatory, 1840 to 1845. (Three vols.) 8vo. (1847.)

Plant, T. L.—Meteorological Diary kept at Vauxhall, Feb. to Sept. 1841, and at Moseley, Birmingham, Nov. 1860 to Aug. 1883. (MS.)

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Reslhuber, P. A.—Die Constanten von Kremsmünster. 4to. (1853.)

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BRYAN, W. B.—Rainfall at Stations in Lancashire and the West Riding of Yorkshire, 1883.

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CHRISTENSEN, H.O.—Specification of Improvements in or relating to Signalling Barometers.

CLARK, J. E.—The Natural History Journal and School Reporter, Nos. 64 to 72.

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CORY, F. W.—How to Foretell the Weather with the Pocket Spectroscope.

DANCKELMAN, DR. A. VON.—Die Ergebnisse der meteorologischen Beobachtungen der Herren Herm. Soyaux und Kapt. R. Mahnke in Ssibange-Farm am Awandu, Gabun, Westafrika wahrend der Jahre 1882 und 1883.—Mémoire sur les Observations Météorologiques faites à Vivi (Congo Inférieur) et sur la Climatologie de la Côte sud-ouest d'Afrique en général.

DAVIS, T. H.—Monthly Wind Roses, Peel, Isle of Man, 1883. (MS.)

DOWSON, E. T.—Weld's History of the Royal Society.

DOXAT, MRS.—Meteorological Journals kept by the late Mr. Doxat. (MS.)

DOYLE, P.—The Cocanada Oil Industry.

ELIOT, PROF. J.—Account of the South-west Monsoon Storms of June 26th to July 4th, and of November 10th to 15th, 1883.

FISHER, W. R.—Journal of Observations of the Weather at Yarmouth, 1793 to 1819, 1821 to 1826, and 1828 to 1832. (MS.)

FOX, W. L.—Meteorological Tables and Notes for the year 1883 for West Cornwall and the Scilly Islands.

FRIESSLING, PROF.—Zur Erklärung der Dämmerungserscheinungen.

GAUTIER, E.—Nouvelle Organisation des Observations Météorologiques à Genève, au Grand St. Bernard et à Martigny.

GLYDE, E. E.—Abstract of Meteorological Observations made at Babbacombe, Torquay, during the year 1883.—Meteorological Summaries for Nov. 1883 to June, and Aug. to Oct. 1884, made at Babbacombe.

HALL, M.—Jamaica Weather Report, Nov. 1883 to Sept. 1884.

HANKINSON, R. C.—Weather at Red Lodge, Southampton, Dec. 1883 to Nov. 1884. (MS.)

HANN, Dr. J.—Einige Resultate aus Major von Mechow's meteorologischen Beobachtungen im Innern von Angola.—Einige Tafeln zur Berechnung des Wasserdampfgehaltes der Atmosphäre.

HARVEY, REV. C. W.—Meteorological Observations taken at Throcking, Herts, during the year 1882.—Rainfall in Herts, April 1883 to March, May, June, and Nov. 1884.—Report on the Rainfall in Hertfordshire in 1882.

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HILDEBRANDSSON, Dr. H. H.—Tromben ved Nöttja den 9 Juni 1883.

HILL, S. A.—On the Measurement of Solar Radiation by means of the Black-bulb Thermometer *in vacuo*.—On the Temperature of North-Western India.

HOSKINS, Dr. S. E., F.R.S.—Elements of the Climate of Guernsey for 40 years.

HUNTER, J. JUNR.—Weekly Summaries of Meteorological Observations at Belper, 1884.

IHNE, Dr.—Beitrage zur Phänologie.

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JOLY, J.—On the Reading of Meteorological Instruments placed at a distance from the Observer.

JUPP, H. B.—Meteorological Observations, as regards Temperature, taken at Clifton, 1881 and 1882.

KAMMERMANN, A.—Résumé Météorologique de l'année 1883 pour Genève et le Grand Saint-Bernard.

KÖPPEN, Dr. W.—Bemerkungen über die verticale Vertheilung des Luftdruckes.—Die taglichen Aenderungen der Windstärke über dem Lande und dem Meere.—Ueber den Gewittersturm vom 9 August 1881.—Ueber den Einfluss der Temperaturvertheilung auf die oberen Luftströmungen und auf die Fortpflanzung der barometrischen Minima.—Ueber monatliche Barometerschwankungen.

LAIS, PADRE G.—La Luce Crepuscolare dell' anno 1884.

LAKE, Dr. W. C.—A Contribution to the Comparative Meteorology of Torquay, Teignmouth, and Sidmouth.

LANCASTER, A.—La Pluie en Belgique.

LECKY, R. J.—A new Method of measuring Heights by means of the Barometer. By G. K. Gilbert.—Record of Sunshine, 1881 to 1883, at Aspley Guise.

LEE, G. J.—Meteorological Observations taken at Kimberley, South Africa, Jan. 1 to Nov. 30, 1884 (MS.).

LOOMIS, PROF. E.—Contributions to Meteorology. Twentieth Paper.

MASSINGHAM, T.—Remarks on Lightning in the Pit at West Thornley Colliery on Dec. 11, 1883. By H. White.

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MCLANDSBOROUGH, J.—Meteorology of Bradford for 1883.

MERRIFIELD, DR. J.—Meteorological Summary for Plymouth for the year 1883.

MONCRIEFF, MISS W. D. S.—Can Man affect the Weather?—The Sun's connection with the Earth.

MOORE, A. W.—Summary of Weather for 1883 in the Isle of Man.

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ORMEROD, G. W.—Rainfall at Teignmouth, 1883.

PAGE, DR. H.—Abstract of the Meteorology of 1883, from Observations taken at Redditch.—Meteorological Observations made daily at 9 a.m. at Redditch during 1883 (MS.).

PHILIPS, J. C.—Traces from Self-recording Aneroid Barometer, 1884.

POGSON, MISS E. J.—Administration Reports of the Meteorological Reporter to the Government of Madras for the years 1882-3 and 1883-4.

PRESTON, REV. T. A.—Wiltshire Rainfall, Dec. 1883 to Nov. 1884.

PRINCE, C. L.—Observations upon the Heat and Drought of the past Summer (1884).—The Summary of a Meteorological Journal kept at Crowborough, 1883.

RAULIN, PROF. V.—Observations Pluviométriques de la France Septentrionale de 1688 à 1870, de l'Algérie et des Colonies.—Observations Pluviométriques faites dans la France Méridionale de 1704 à 1870 avec les grandes séries de Paris, Genève et le Grand St. Bernard. Parts 2 and 3.

RICHARDS, W. H.—Abstract of the Weather at Penzance and neighbourhood for the year 1882.

ROPER, W.—Statistics of Lancaster Rainfall and other local meteorological information, 1784 to 1883.

ROTH, H. L.—On the Roots of the Sugar Cane.—The Mackay Sugar Crop as affected by the Weather and Want of Labour.—The Sugar Industry in Queensland.

RUSSELL, H. C.—Anniversary Address delivered to the Royal Society of New South Wales.—The Spectrum and Appearance of the recent Comet (1881).

SCHÜCK, CAPT. A.—Beiträge und Bemerkungen zu unserer Kenntniss der Wirbelstürme oder Cyclonen.

SCOTT, R. H., F.R.S.—Ideas sobre una exploracion sestemática del Clima de la Provincia de Córdoba sin instrumentos. Por O. Doering.—La Prévision du Temps. Par Zurcher et Margollé.—La variabilidad interdiurna de la temperatura en algunos puntos de la República Argentina y de América del sur en general. Por O. Doering.—Note on a Series of Barometrical Disturbances which passed over Europe between August 27th and 31st, 1883.—Report from H. B. M. Consul at Batavia enclosing Extract relating to the Volcanic Outbursts in the Sunda Strait, from the Logbook of the Steam-ship *Governor General Loudon*.—Sullo Stato Sferoidale. Nota di Prof. G. Luvini.

SMYTH, PROF. C. PIAZZI.—Bright Clouds on a Dark Night Sky.

STOKES, J.—Report of the Medical Officer of Health for the Borough of Margate for the year 1883.

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„ 'Nature,' Nos. 740 to 791.
„ 'Science,' Nos. 46 to 97.
„ 'The American Meteorological Journal,' Nos. 1, and 5 to 8.
„ 'The Illustrated Science Monthly,' Nos. 3, 4, 6 to 8, and 11 to 14.
„ 'The Sanitary Engineer,' Vol. IX. No. 2 to Vol. XI. No. 3.
„ 'The Telegraphic Journal and Electrical Review,' Nos. 319 to 370.

THORPE, J.—On the Bowen Cyclone of January 30, 1884.

TURTLE, L.—Review of the Weather of 1883 at Aghalee, Co. Antrim.

TYRER, R.—The Meteorology of Cheltenham.—Abstract of Meteorological Observations made during 1883.

WALFORD, CORNELIUS.—A Statistical Chronology of Plagues and Pestilences as affecting Human Life, with an inquiry into their causes.

WILLIAMS, Dr. C. T.—The Climate of the South of France.

WISE, DR. A. T.—The Alpine Winter Cure.

WORTH, J. E.—The Meteorology of Burslem for 1882 and 1883. (MS.)

WRAGGE, C. L.—On Types and Forecasts of Weather.—Remarks on the "Red Glow."

APPENDIX VII.

REPORTS OF OBSERVATORIES, &c.

THE METEOROLOGICAL OFFICE.—Lieut.-Gen. R. Strachey, R.E., C.S.I., F.R.S., Chairman of Council; Robert H. Scott, M.A., F.R.S., Secretary; Captain H. Toynbee, F.R.A.S., Marine Superintendent; Nav. Lieut. C. W. Baillie, F.R.A.S., Assistant Do.—The only change which has taken place in the Council during the year has been the substitution of Captain W. J. L. Wharton for Sir F. J. Evans,

K.C.B.; a change which was rendered necessary by the expiration of the term of office of Sir F. J. Evans as Hydrographer, and the consequent appointment of his successor.

Marine Meteorology.—The investigation into the Meteorology of the North Atlantic for the thirteen months ending with August 1883 still occupies the main part of the office staff in this department. The total number of forms received for the thirteen months has been 11,222, being an average of 863 per month; this yields an average of about 400 observations per day, exclusive of land stations, so that the charts will be more completely filled up with data than any others that have as yet appeared. The discussion and charting of these observations is progressing satisfactorily.

The Charts of the Surface Temperature of the three oceans have been published, and those of the Barometrical Pressure for the same areas are in an advanced stage.

The Barometer Manual for Seamen was published in the summer, and it is hoped that it will be found useful to the community for whom it is intended.

Weather Telegraphy.—The changes in this department have been considerable. New stations have been established on the extreme Northern (Malin Head) and North-western (Belmullet) points of Ireland. The station at Hawes Junction has been suppressed as far as the telegraphy of the reports, but the observations are still taken there and transmitted by post.

It is with regard to the publications of this branch that the most important changes have been chronicled. In the first place, as indicated in the last Report of this Society, the cumulative temperatures for the several districts have been given in the *Weekly Weather Report*, and also the cumulative number of rainy days and cumulative amounts of Rainfall and of Bright Sunshine. In the Appendix to the *Weekly Weather Report* will be found the same data for each week for the last seven years for each of the above elements excepting the Sunshine, of which the records only go back to 1880. These tables afford a most valuable storehouse of information for researches on phenological and allied subjects.

The *Monthly Weather Report*, which has appeared regularly, is a monthly resumé of the weather from the Telegraphic Reporting Stations as well as those furnishing information for the *Weekly Weather Report.*

The Office has made arrangements with the Chief Signal Office at Washington for the telegraphy of reports of Storms, Icebergs and derelict ships from steamers arriving from Europe in the ports of New York and Boston, and the service was commenced in December.

Land Meteorology of the British Isles.—There is not much to report in this department. The volume of reports from stations of the Second Order for 1880 has appeared, and that for 1881 is in hand.

The volume of *Hourly readings* from the observatories for 1882 has appeared.

A good deal of the attention of this department has been devoted to the investigation of the barometric waves produced by the Eruption of Krakatoa in August 1883.—*March* 30, 1885.

ROYAL OBSERVATORY, GREENWICH.—W. H. M. Christie, M.A., F.R.S., Astronomer Royal.—The observations are continued on the same general plan as in recent years.

Owing to various causes the new thermometer apparatus for photographic record of dry and wet bulb indications, spoken of in the last Report as in preparation, has not yet been brought into use. It is hoped that this may before long be done.

The observations of the temperature of the river Thames, recommenced in the year 1883 under the Corporation of London, were interrupted during the autumn of the year 1884 owing to the thermometers having been broken. New thermometers were supplied, and the observations were in December again commenced. —*March* 6, 1885.

ROYAL OBSERVATORY, EDINBURGH.—Professor C. Piazzi Smyth, F.R.S.E., Astronomer Royal for Scotland.—During the year 1884 the double daily obser-

vations taken so perseveringly at fifty-five stations of the Scottish Meteorological Society have been computed at this establishment for the Registrar General of Births, Deaths, &c. in Scotland, and have been printed in his successive Monthly and Quarterly Reports.

The small Meteorological Journal for the circumstances of the Clocks and Optical instruments has been kept up as usual, also the readings of the Rock thermometers.

A new set of tables of the average Meteorology of all Scotland in every month and in each year during the last twenty-nine years has been prepared, but will not appear until permission shall have been obtained from H.M. Government to resume the observatory printing.

The broad claret coloured halo in the upper air, above 45° in external breadth, round both Sun and Moon, has been an object of frequent though informal observation throughout the past year, while latterly some special appearances of iridescent clouds, with brilliant central green bands placed diagonally, and passing off on either side into a bright blue and violet, and then into a reddish border—reminding one more of scales of a diamond-beetle viewed by vivid reflected light in the dark field of a compound microscope than any ordinary clouds of either Sunrise or Sunset—have demanded special attention both morning and evening.

Extensive Solar-spectrum observations have been taken during the summer, and are now being computed and prepared for presentation probably to a scientific Society in Edinburgh, and might have been expected perhaps to throw some light on these unusual luminous phenomena; but so far as the work of reduction and comparison has yet proceeded, nothing except a dulling of either end of the visible spectrum has yet manifested itself. Whence the conclusion is pretty evident, that although there may be at present an unusual amount of finely divided dust of solid and insoluble particles, aggregating minute ice-crystals to themselves, in the more elevated regions of the atmosphere,—there is no advent of any new gas, capable of making lines in the Solar spectrum, in the manner so typically characteristic of any and every true gas, yet testified to. —*January* 10, 1885.

THE KEW OBSERVATORY OF THE ROYAL SOCIETY, RICHMOND, SURREY.—G. M. Whipple, B.Sc., F.R.A.S., Superintendent.—The several self recording instruments for the continuous registration respectively of atmospheric pressure temperature, and humidity, wind (direction and velocity), bright sunshine, and rain, have been maintained in regular operation throughout the year. The tabulation of the traces has been regularly carried on, and copies of these, as well as of the eye observations, with notes of weather, cloud, and sunshine, have been transmitted weekly to the Meteorological Office.

A report on the Stewart actinometer observations made last year was submitted in December to the Meteorological Council, at whose expense the observations were carried on, and it was resolved to discontinue them. The instrument has since been returned to Professor Balfour Stewart.

In conformity with a suggestion contained in an article in *Symons's Meteorological Magazine*, Vol. xviii. p. 58, a painted board has been set up to the north of the Observatory, to serve as a gauge for measuring the intensity of fogs. Since its erection in January last no fog, however, has been observed of intensity 1 on its scale.

Experiments have been made with a new pattern thermometer, designed by Messrs Negretti and Zambra for observations of nocturnal terrestrial radiation, with a view to the avoidance of several serious defects in the Rutherford Minimum, now generally used. Very favourable results were obtained until the instrument was damaged, and had to be sent back to the makers. It has not yet been returned to the Observatory.

Various experiments have been made with the Photo-nephograph during the year, but in consequence of the short base line obtainable, with the small amount of connecting wire available for working the pair of cameras, very few satisfactory determinations of cloud altitudes have been made. A report having, however, been submitted to the Meteorological Council, that body has granted funds

to the Kew Committee for the purpose of purchasing a half-mile of double wire telegraphic cable and reel, together with switches and keys, in order that the two cameras may be worked at a distance of 800 yards apart. A stand has been erected on the roof of the Observatory, where camera A will be permanently placed, and camera B will be similarly supported by another permanent stand at the other end of the cable. Both cameras being oriented with reference to the same point of the horizon, the distant observer will be instructed as to the direction and elevation of his instrument by means of a telephone switched on to the line for the purpose. Experiments with the new arrangement are now being made, and should they prove successful it is intended to bury the cable in the ground across the park beside the Observatory gas main, thereby obviating the present necessity of laying out and winding it in again every time it is desirable to make cloud altitude and air-current motion determinations.

The experiments with a view to determining the causes of variation in the readings of similarly constructed and exposed black bulb thermometers *in vacuo* have been continued during the year. The first series of observations having been concluded, and the results communicated to this Society,[1] the six thermometers were returned to Messrs. Negretti and Zambra, in order that all might have their bulbs coated with three coats of lampblack and their jackets altered: one pair is now enclosed in small bulbs, a second pair in medium, and the third pair in large bulbs. With the exception of one which was accidentally broken in July, they have been read daily since May 3rd. The results have not yet been fully discussed, but a cursory inspection appears to indicate that the larger the containing bulb the lower is the reading of the enclosed blackened bulb thermometer.

Assistance has been given to a Sub-Committee of the Sanitary Institute in their experiments on the motion of air in ventilating tubes, which have been carried on during the summer under the charge of Mr. R. Rymer Jones, C.E., in a hut erected for the purpose adjacent to the Observatory. The experiments are in continuation of those prosecuted in the experimental house in 1880.

At the request of Mr. Walter Baily, M.A., a wind-component integrator of his invention, described in the *Philosophical Magazine*, Vol. xvii. p. 482, has been erected in the experimental house, being attached by permission of the Meteorological Council to their spare Beckley Anemograph. Some difficulties were experienced on account of the unsuitability of the electrical counters fitted to it for registration of light winds, but these have now been overcome, and the instrument is working satisfactorily.

The number of instruments verified during the past year amounted to about 11,000, again showing a large augmentation as compared with the preceding year. A new department devoted to the rating and certifying of watches for manufacturers and for the public has been inaugurated during the year, and up to the present date has proved very successful.—*January 8th*, 1885.

RADCLIFFE OBSERVATORY, OXFORD.—E. J. Stone, M.A., F.R.S., Radcliffe Observer.—No important changes have been made in the instrumental equipment or in the plan of observations during the past year. Readings of the standard instruments are frequently taken during the day, and also, by the assistant on astronomical duty, during the night, for check of the scale of the photographic curves.

The index errors of the thermometers were verified by Mr. Whipple on September 3rd. On January 26th the anemograph was severely shaken and some of the screws worked loose. It was temporarily repaired on January 27th, but on February 26th the instrument was dismounted and sent to Adie's, London, for thorough repair; it was remounted on March 10th, and has since worked satisfactorily. The rain-gauges have been from time to time tested and are in good order. The photographic curves throughout the year have been generally good.

The meteorological observations for 1881 have been printed and distributed; the results for 1882 are in the printer's hands; and those for 1883 are under discussion.

[1] *Quarterly Journal*, Vol. x. p. 45.

The barograms and thermograms are scaled and tabulated to the end of 1883, the anemograms and rain-gauge curves to the end of 1884, and the sunshine cards to date.

For the past year the mean temperature was 50°·4, being 1°·4 above the average for the last twenty-nine years; whilst the rainfall was 18·918 ins., being 7¾ ins. below the average for the last thirty-three years.

Weather reports have been supplied daily (by telegram) to the Meteorological Office; bi-monthly to the United States Signal Office; monthly to the Registrar-General and the local newspapers; yearly for insertion in *Symons's British Rainfall;* and to meteorologists by request.—*January* 12, 1885.

CAMBRIDGE OBSERVATORY.—Professor J. C. Adams, M.A., F.R.S.—The meteorological work at this Observatory has been carried on as in former years. No change has been made in the instruments.

The year has been remarkable for its dryness, and many wells have been dried up which were never known to have been dry before. From accounts given by the farmers, the crops were good. The frost in April did a great deal of mischief to stone fruit, apples and pears, but currants and gooseberries were plentiful. The earthquake on April 22nd was felt in the central part of the town. At the Observatory the adjustments of the Transit Instrument were being made, and while the level error was being determined the mercury became suddenly unsteady, the observer having to wait some little time, thinking it was caused by a passing waggon. No other disturbance was noticed.

The mean reading of the barometer for the year was 29·980 ins., and the mean temperature (mean of maximum and minimum) 49°·8. The mean reading of the dry bulb thermometer was 50°·5, wet bulb 47°·7, maximum 58°·4, and minimum 41°·1. The total rainfall was 18·180 ins., the average for the last twenty years being 23·767 ins. The wind blew chiefly from between South and West. Bright sunshine was registered during 1463·3 hours.—*January* 15, 1885.

STONYHURST COLLEGE OBSERVATORY.—Rev. S. J. Perry, M.A., F.R.S.—The Meteorological, Magnetic, and Astronomical Work of this Observatory has been carried on entirely as in former years, and no interruption has occurred in the record of the self-registering instruments. The Meteorological and Magnetic Observations taken in connection with the Polar Expeditions have been copied, and the greater part have been forwarded to Dr. Wild of St. Petersburg. Agricultural and Sunshine Reports are sent to the Meteorological Office, Synchronous Observations to Washington, and Monthly Tables of Daily Observations to the French Meteorological Society. The Meteorological Office receives along with the Monthly Tables the duplicate copies of the Meteorological curves. The Upper Clouds are recorded as usual for the Upsala Observatory, and various information has been sent during the year to those periodicals and individuals who have applied to the Observatory. The Magnetic Photographic Traces are at present being compared by Dr. Balfour Stewart with those of Kew.—*January* 19, 1885.

THE ANOMALIES IN THE ANNUAL RANGE OF TEMPERATURE. HOW TO DETECT THEM. By Dr. C. H. D. BUYS BALLOT, LL.D. Edinb., Hon.Mem. R.Met.Soc.

[Read February 18th, 1885.]

IT is quite impossible now to calculate by theory the rise and fall of temperature from day to day in a given place on the earth's surface, and I think it will be very long before we succeed in doing so. We may find by Meech's formula how much heat is taken up every day on each parallel, and how much is lost

by radiation within a given twenty-four hour period. These quantities would be only applicable to our globe if it were without atmosphere or water.

If there were only air above the surface all places on the same parallel would enjoy the same temperature did not mountains cause a disturbance. But the water of the ocean, as well as the air, conveys away the heat of the equator to the poles, and counter-currents deflected by the earth's rotation, by the form of the coasts, and by the irregular depths of the oceans, bring down their ice-waters and cold air to lower latitudes. Now as coasts trend more or less in the directions of the meridians, the induced sea and land winds produce Easterly and Westerly currents, disturbing the polar and equatorial winds. Finally, aqueous vapour is formed under the tropics and condensed again in other latitudes; accordingly the complication is so great that we cannot as yet dream of finding a mathematical formula expressing the temperature of a certain day at a given place. Nevertheless, I think it still impossible to find a solution, even by proceeding in the way I indicated in the discussion of the observations at Breda, by Wenckebach, 1847, and in the *Fortschritte der Physik*, 1858.

We are compelled to recur to practical observation continued through a long series of years for each place, as we are not satisfied with von Lamont's values for each parallel, nor with the admirable isothermal charts suggested by Humboldt and given by Dove and Wild; for in these charts we find only the mean value for each month, and it will be long before we have isotherms for each day for the whole of the surface of our globe.

In the mean time we have to follow an opposite course, and to inquire *à priori* not how some days and places must be disturbed by the multifarious circumstances and influences, but rather if some days be more disturbed than others, and if so, why?—We have to investigate how such deviations of temperature and barometric pressure produce motions of the atmosphere and disturbances at other surrounding places (such as Prof. von Bezold has expressed the intention of discussing).

We accordingly must seek for deviations, not from the present imperfectly known average theoretical state of things, but from the actual regular rise or fall in the course of the year. We have to discover if the range of temperature really does present such irregularities or anomalies, and if found in a continually increasing number of places, we have afterwards to connect them and to find the answer to this question.

I shall prove it to be probable that only a long continued series of observations can give evidence of an interruption of rise and fall, especially in latitudes where the temperature of the same day in different years may vary by 20° C., such as at St. Petersburg, where days of mean temperature occur at every date of the year, as we may see from Table I.,[1] ex-

[1] Table I. records how often a given mean temperature of the day—as found in Wahlén's paper, *Repertorium für Meteorologie*, Vol. VII. No. 7—has been n degrees, $n + 1$ degrees, &c. and in which month of the year this has occurred. For the Helder a similar table is to be found in *Meded. Kon. Akad. van Wetenschappen*, Amsterdam, 2nd series, IX.

TABLE I.

Showing how often each of the indicated Mean Temperatures of a day has been observed at St. Petersburg in the different months of 118 years.

Mths.	−37°	−36°	−35°	−34°	−33°	−32°	−31°	−30°	−29°	−28°	−27°	−26°	−25°	−24°	−23°	−22°	−21°	−20°
Jan...	1	1	1	1	1	3	2	4	5	15	13	7	19	35	35	44	52	63
Feb...	..	..	..	..	1	4	5	3	5	11	21	13	30	18	29	39	47	60
Mar.	..	..	..	..	..	..	..	..	..	..	..	2	1	6	5	8	4	9
April	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
May..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
June	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
July..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Aug...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sept.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Oct...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nov...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	1	..	..
Dec...	..	..	1	..	3	..	3	6	5	8	9	15	18	12	17	20	24	42

Mths.	−19°	−18°	−17°	−16°	−15°	−14°	−13°	−12°	−11°	−10°	−9°	−8°	−7°	−6°	−5°	−4°	−3°	−2°
Jan...	75	98	95	109	120	113	141	131	156	165	186	165	189	185	166	91	175	171
Feb...	74	79	93	98	107	118	141	137	141	162	191	178	201	192	188	201	221	191
Mar...	15	20	17	38	36	65	64	93	111	131	145	158	163	192	215	233	230	237
April	..	..	1	1	2	1	3	5	11	15	16	25	31	51	70	93	107	156
May..	..	..	..	..	..	..	..	..	..	...	..	..	..	..	1	2	3	10
June	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
July..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Aug...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sept.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Oct...	..	..	..	..	..	..	..	..	..	1	6	3	8	9	19	34	43	66
Nov...	4	4	5	10	14	19	35	33	36	63	74	93	109	162	140	192	204	223
Dec...	40	54	42	65	79	92	101	106	115	148	179	146	162	194	173	225	241	240

Months.	−1°	−0°	+0°	+1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°
January	184	160	118	124	86	14	4	..	..	..	..	..	..	..	..	..
February	192	84	109	133	72	14	1	..	..	..	..	..	..	..	..	..
March	256	271	302	256	165	72	25	8	4	..	1	..	..	..	..	..
April	207	196	281	414	550	348	294	212	180	133	99	72	38	29	19	16
May	10	43	75	101	128	201	219	281	285	298	298	289	270	261	226	179
June	..	..	..	..	1	4	7	18	40	60	72	135	189	252	330	362
July	..	..	..	..	..	..	..	1	1	..	6	12	24	79	112	222
August	..	..	..	..	..	..	..	..	1	6	19	49	77	149	256	337
September	..	1	6	24	36	62	99	128	177	220	292	351	379	396	385	316
October	120	166	231	282	353	292	345	368	336	305	272	229	143	89	28	22
November......	266	303	377	362	295	196	143	113	70	35	15	6	5	1	..	..
December......	231	209	301	248	102	31	7	4	..	..	..	..	..	..	..	..

Months.	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°
January	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
February	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
March	..	..	..	..	..	.	..	..	..	..	..	..	..	..	..	..
April	7	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..
May	125	119	63	43	41	27	25	5	3	3	..	..	..	..	..	..
June	357	360	330	307	227	178	113	89	56	33	11	6	2	1	..	..
July	312	416	424	396	368	321	318	260	182	117	53	31	14	4	1	..
August	436	500	480	438	290	225	164	125	72	41	14	7	3	..	..	1
September	228	176	110	67	38	9	10	5	2	..	..	..	..	..	..	..
October........	3	4	1	..	..	..	..	..	..	..	..	..	..	..	..	..
November......	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
December......	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

hibiting how often a given mean temperature of a day has occurred in each month. This table is constructed after the model of that which I prepared for the Helder, and is extracted from the original table in my possession, which exhibits the same thing for the first and second halves of each month separately. From it we learn, for instance, that the temperature of a day in the beginning of January may vary between $-37°$ C. and $+5°$C., and that even in May the temperature of a day may range over 22°; in June, July, and August, over 23° and 25°; while in the other months it may vary much more. The temperatures 2°, 3°, 4°, 5°, and 6° are common to nine months. How, then, can we be sure from a series of observations only continued for a century, that an anomaly of some tenths of a degree is not merely apparent, but really exists?

Before 1850, the number of places for which the temperature of every day had been calculated was very small, and Dove, the father of the second era of Meteorology, was perhaps right to ask (in accordance with the common belief in the malicious power of the three ice saints) if the then existing observations did not establish the fact of an irregular fall in the first and middle days of May. Erman also inquired if a ring of cosmic matter did not pass in the early days of February between the sun and the earth, lowering the temperature. Both opinions seemed to be confirmed, and Dove and others sought for an explanation. But the fact itself was not proved, for it had not been possible either to prove or deny it, and I see great difficulty in proving it. For even could we always find a depression of temperature on certain days, it seems nearly impossible to demonstrate that it is a real depression, and not an apparent one caused by the excess of temperature of the foregoing and following days, which may be unduly elevated.[1] Such questions can only be decided by a full investigation of the theory, and possibly by comparison of these disturbances with those at other stations. To decide the point it may perhaps seem best to some to calculate the temperature by Bessel's formula, and ascertain the rate of rise and fall by differentiation. The operation would be easy enough were it the true solution.

Unhappily, the formula itself is only an interpolated one, by omitting some terms containing the higher multiples of the arc. In general the coefficients of these terms are small, and are not very much required in the principal formula; but these are just the terms which acquire more weight on differentiation. Moreover, these terms would not be so small if they were computed from 365 data instead of from 12. I prefer the mode of calculation which I shall recommend and employ in this paper, to the labour of calculating the Bessel's formula from 365 data. It will be a saving of trouble and a gain in accuracy.

It is necessary to ascertain the true temperatures of each day separately. Dr. Hellmann has given[2] an interesting table of the temperature values of

[1] *Changements Périodiques de Température.* Utrecht, 1847, pp. 24-30.

[2] Dr. G. Hellmann, *Ueber den jährlichen Gang. der Temp. in Nord Deutschland*, Kon. Preuss. Statist. Bureau, 1883.

each pentade (five-day period) for twenty-five places in Germany deduced from the records of a long series of years, and this table seems at first sight rather favourable to the opinion of those who dream of anomalies existing at given epochs of the year, because irregular numbers appear in every place. On a closer examination, however, we see the rise after January and fall after July and in the four winter months regularly enough. If we take the differences between the values of each of the five-day means, and call these differences anomalies, when they have the sign opposite to that which we should expect, we have only the following anomalies to record.

In January the sixth pentade shows an anomaly in eighteen places. In February the first pentade in ten, the third in all places, the fifth in nineteen places; the third pentade of March is generally irregular; the second in April is irregular in thirteen, the sixth in twenty-seven places. No anomaly is observable in May. The third in June gives an anomaly in twenty-four places; the first in July in eight, the sixth in twenty-seven places. The first in August in two, the sixth in three places. The first in September in eight places, the sixth in sixteen places, the fifth in November in twenty-three places. In December the second in twenty-three, the third in eleven, the fifth in four, and the sixth in nineteen places.

I may, however, call the Society's attention to the fact that if pentades (or five-day periods) were fully sufficient to exhibit anomalies, they would leave the month of May free from all anomaly, for while these appear frequently enough in other months—the series of observations being only for forty years—the months of May and October are free from them. But these periods are not sufficient to show all the irregularities in this manner, as I have indicated in my letter to Kämtz, (*Repertorium für Meteorologie*, 1860, I. 282) and in the *Marche Annuelle*, 1861: for if, for instance, May 12th were much too cold, May 6-7 and 13-15 being much too warm, it would not be indicated by the pentades when only one set of them is given. If we intended to show all irregularities by pentades, we should have to add to them others beginning with the 2nd, 3rd, 4th, and 5th of January, in all 365 pentades; one series of which might perhaps show us what another concealed.

It seems strange that those who object to take July 31st, Aug. 31st Oct. 31st, and Dec. 31st, as a sixth day added to the last pentade of these months respectively, do not see the advantages of such a plan. Their only objection to it seems to be the slight irregularity of the intervals.[1] They do not see the advantages of a plan which would prevent confusion of the months, for six of the pentades would belong to each month, and not merely to the first five months, while each pair of pentades corresponds to the[2] decades of the Italian, Spanish, &c. publications.

[1] This inequality scarcely exceeds one-half of a day; and what is that inequality to the disturbances by which, even in a series of years, one pentade seems to have the temperature belonging to another?

[2] Happily until May 31st, Mahlman's five-day periods exactly correspond with mine.

Besides they would have seventy-two instead of seventy-three intervals, a form more appropriate for their cherished Harmonic or Bessel's Formula. Even if all pentades were completed, I think we can do better by calculating shorter intervals. If we throw five days together, the temperature of any one of them is not prominent enough to attract attention. Perhaps to give the temperature of each single day is still premature, because of the great periodic disturbances. A combination of three or of two days might be more appropriate, provided we gave the temperature for each duad or each triad, that is, for $1 + 2$, $2 + 3$, &c., $1 + 2 + 3$, $2 + 3 + 4$, $3 + 4 + 5$, and so forth. When Prof. von Bezold was writing his paper on the temperature of Munich, I made him a proposal as to the method to be selected, and told him that I would accept any method on which both he and Professor Hann should agree. Prof. von Bezold was so kind as to reply that the calculations were then already nearly completed; therefore not having met with any opposition, I give the following discussion of the observations at eighteen places, some of which, being represented by a very long series, are given in triads (3-day periods) according to my earlier researches.[1] Dr. Wahlén has calculated the mean temperatures of each day for two separate series of years, which I give in Table II., in order to show what great discordances remain in such a climate even for two series of fifty or more years. The temperatures of the first series are often more than 2° lower than those of the second. This, however, does not much affect the accuracy of the result (consisting of differences of consecutive days); certainly not if this difference is only to be attributed to an error in the exposure of the thermometers or in their zero points. Moreover, I combine these two results, and apply my method fully to the mean of these two series, as shown by an example in Table III., which model I have also followed for the other sixteen places. I prefer to give the whole of the operations, because they are so conducted that it must be clear to every one, that you can in this manner with the greatest ease apply most of the methods followed by some distinguished meteorologists, and examine the rate of the rise and fall of temperature from three-day or from four-day periods, whilst it is easy to find the average of nine days, taking four days before and after each date, and so on.

I may refer for instance to the month of May. In these columns I call p the sum of the 1st, 2nd and 3rd of the month, and q the sum of the 2nd, 3rd and 4th, and so forth, as has been indicated by the letters after these sums of temperature; then $\frac{p}{3}, \frac{q}{3}, \frac{r}{3}$, are the somewhat smoothed means for May 2nd, 3rd and 4th; $\frac{p + v + s}{9}$ is the temperature of the 5th, if you wish to deduce that temperature from nine days. Perhaps it may be wished to avoid dividing by nine, in which case you may add the temperature of the 5th, and you will then have ten times that temperature, giving a somewhat greater

[1] *Verslagen en Mededeelingen van de Kon. Akad. van Wetenschappen.* Amsterdam, Serie II. dul. IX.

TABLE II.

Mean Temperature of each day deduced from two series of years at St. Petersburg.

TABLE III.—St. Petersburg.

A. True mean temperature; B. C. D. sum of three succeeding mean temperatures; E. sum of three consecutive triads; F. mean temperature of each day from these triads after adding again the temperature of the same day; G. sum of three triads $p+s+v$ not having the same temperature in common = the sum of nine consecutive days; H. mean of the corresponding day from these nine, *plus* the temperature of that day; I. threefold the difference of $(4+5+6)-(1+2+3)$ *a. s. f.*; K. difference of 6—1, 7—2, etc. = rise within five days.

Date.	MAY. 1743 to 1821.	MAY. 1822 to 1878.	MAY. A.	B.	C.	D.	E.	F.	G.	H.	I.	K.
	°	°	°	°	°	°	°	°	°	°	°	°
1	5·11	4·63	4·87	p14·65	..	..	44·23	49·10	45·19	5·006	1·49	3·07
2	5·35	4·94	5·15	..	q15·57	..	46·74	51·89	47·59	5·274	1·44	2·96
3	5·30	5·80	5·55	..	..	r16·52	48·81	54·36	49·76	5·531	1·18	2·71
4	5·59	6·06	5·82	s17·72	..	..	52·77	58·59	51·98	5·780	1·02	1·89
5	6·33	6·36	6·35	..	t18·53	..	55·48	61·83	53·99	6·034	1·05	1·56
6	6·94	5·74	6·36	..	..	v19·23	57·37	63·73	56·72	6·308	1·46	1·74
7	7·13	5·87	6·52	v19·61	..	..	58·93	65·45	59·39	6·591	1·57	2·45
8	7·27	6·14	6·73	..	20·09	..	60·67	67·40	61·93	6·866	1·54	3·22
9	7·13	6·54	6·84	..	..	20·97	63·12	69·96	64·38	7·122	1·76	3·21
10	7·53	7·25	7·40	22·06	..	..	66·34	73·74	66·63	7·403	1·54	2·90
11	8·03	7·60	7·82	..	23·31	..	69·55	77·37	69·21	7·703	1·55	2·50
12	8·31	7·85	8·09	..	..	24·18	72·45	80·54	72·06	8·015	1·49	2·73
13	8·52	8·00	8·27	24·96	..	..	74·95	83·22	74·91	8·318	1·52	2·93
14	9·04	8·14	8·60	..	25·81	..	77·68	86·28	77·86	8·646	1·16	2·93
15	9·50	8·35	8·94	..	..	26·91	80·61	89·55	80·22	8·916	0·68	2·22
16	10·06	8·66	9·37	27·89	..	..	83·54	92·91	82·02	9·139	0·31	1·28
17	10·40	8·72	9·58	..	28·74	..	85·76	95·34	83·61	9·319	—0·27	0·32
18	10·52	9·03	9·79	..	..	29·13	87·04	96·83	84·65	9·444	—0·18	—0·52
19	10·28	9·20	9·76	29·17	..	..	87·36	97·12	85·66	9·542	0·28	—0·57
20	9·72	9·52	9·62	..	29·06	..	86·84	96·46	86·76	9·638	0·75	0·10
21	9·94	9·40	9·68	..	..	28·61	86·27	95·95	87·76	9·744	1·16	1·41
22	9·52	9·08	9·31	28·60	..	..	86·17	95·48	89·02	9·833	1·99	2·65
23	9·81	9·39	9·61	..	28·96	..	87·58	97·19	90·53	10·014	1·63	3·55
24	10·08	10·00	10·04	..	..	30·02	90·23	100·27	92·01	10·205	—0·01	3·36
25	10·28	10·46	10·37	31·25	..	..	93·78	104·15	93·77	10·414	0·08	2·67
26	10·88	10·81	10·84	..	32·51	..	97·14	107·98	95·54	10·638	0·68	1·56
27	11·42	11·17	11·30	..	..	33·38	99·81	111·11	97·75	10·905	0·62	0·97
28	11·44	11·04	11·24	33·92	..	..	101·37	112·61	100·06	11·130	0·00	0·97
29	11·13	11·65	11·38	..	34·07	..	102·34	113·72	102·26	11·364	0·45	1·61
30	11·37	11·55	11·45	..	..	34·35	103·31	114·76	104·72	11·617	1·79	2·64
31	11·86	11·16	11·52	34·89	..	..	104·92	116·44	107·12	11·864	2·10	3·42

	v-p	t-q	u-v
s-p	3·07	2·96	2·71
v-s	1·89	1·56	1·74
y-v	2·45	3·22	3·21
etc.	2·90	2·50	2·73
	2·93	2·93	2·22
	1·28	0·32	—0·52
	—0·57	0·10	1·41
	2·65	3·55	3·36
	2·67	1·56	0·97
	0·97	1·61	2·64

weight to the day itself. Again, taking $p + q + r, q + r + s, r + s + t$, then you have—

once the temperature of the 1st and 5th,
twice „ „ 2nd and 4th,
and three times „ „ 3rd,

which sum you may take as nine times the temperature of the 3rd, or (if you give the third the weight of four) ten times that temperature by again adding its own temperature.

By writing these sums p q r in three columns I have the advantage of seeing directly by one subtraction the rate of the rise or fall of temperature every three or four days; $s-p$ is the sum of the temperatures $(4+5+6)-(1+2+3)$ and gives the rise within six days; so $q-p$ is the temperature of the 4th *minus* the temperature of the 1st. In May there is no $v-p$, &c. negative. The sign $-$ indicates irregularity. In Table III. 1st column, I have underlined all such numbers which seemed irregular, that is, all such values which before the epoch of the maximum, when they should be increasing, are less than a foregoing value, or which after the maximum, are greater than the preceding temperatures. So that one sees at once all the anomalies.[1] In Table IV. I have given for each place the number of anomalies that occur in every month, their dates, and the difference between the day of greatest anomaly and the last regular day. If this difference does not exceed 0°·1 or 0°·2, there is not much reason to think it real; at least, one has no right to say that a depression is met with in the former, or an elevation in the latter half of the year, especially in the months near to the extreme temperatures, for which the epoch and value have been given in Table V. But it may be that the preceding day or days have 0°·1 too much, for surely we do not know the daily temperature within 0°·1 from even one hundred years' observations.

Looking through Table IV. it will be seen that there are no great anomalies in May, and a very few in the latter months of the year,—in autumn, when, as Dove said, "Nature goes quietly to sleep, to awake in a fever in the spring."

The supposed anomalies do not maintain their character, for in the course of years we have the true temperatures at every date for more places as the series of observations grows longer and more complete. The dates of the anomalies change, the anomalies themselves become more uncertain and disappear; which should not happen if they had a real existence.

To show if the days of anomaly are common to many localities, I have appended Table VI. for nine months of the year, leaving out the months which are too near the minimum and maximum. This table indicates how many of the eighteen stations exhibit a disturbance on a certain day of the month.

The following objection must also be met. Admitting that the apparent disturbances in the course of the year are fictitious, may there not exist a real change in the rate of rise or fall at any particular periods? This I admit, and shall try to give a means of comparing the simultaneous rate of the rise at different stations. To find this, I have collected at the foot of Table III. all the differences $s-p$ for St. Petersburg, so that in these differences we may study the required rate. I have also added columns containing all the differences of the temperature at a certain date from that of a date five days earlier. In the *Archives Néerlandaises* XVII., I gave the difference between days with an interval of ten days; but on the supposition that it will be

[1] Table III. is not printed in full. The figures for the Month of May are alone given. The columns I and K however for each month will be found in Table IIIA. (p. 112.)

TABLE IIIa.—Giving the values I. and K. for every month at St. Petersburg.

Date.	January.		February.		March.		April.		May.		June.	
	I.	K.	I.	K.	I.	K.	I.	K.	I.	K.	I.	K.
	°	°	°	°	°	°	°	°	°	°	°	°
1	0·01	0·84	0·23	1·98	0·75	0·54	0·30	2·98	1·49	1·07	1·87	4·01
2	−0·31	0·82	0·08	0·97	0·55	0·52	0·98	2·18	1·44	2·96	1·98	3·66
3	1·24	0·92	0·30	1·06	0·66	1·33	0·40	1·97	1·18	2·71	1·34	3·32
4	1·30	−2·15	0·42	−0·47	1·06	1·89	0·49	0·80	1·02	1·89	1·28	2·49
5	2·01	−2·99	1·20	0·63	0·17	1·72	0·92	0·87	1·05	1·56	0·53	2·26
6	1·24	−3·68	1·32	2·55	−0·09	0·66	1·39	1·22	1·46	1·74	0·36	1·21
7	1·34	−2·49	0·93	3·07	0·54	−0·30	1·65	2·84	1·57	2·45	0·07	0·64
8	−0·71	−1·28	0·02	2·70	0·86	−0·32	1·90	3·72	1·54	3·22	0·24	−0·32
9	−1·21	1·53	−0·01	0·38	0·88	1·31	1·33	3·49	1·76	3·21	−0·31	0·01
10	−2·96	3·04	−0·29	−1·66	1·17	2·86	1·31	2·51	1·54	2·90	0·61	0·09
11	−1·30	3·79	−0·12	−2·37	1·28	2·95	1·42	1·80	1·55	2·50	0·99	0·79
12	−1·28	2·75	−0·07	−0·73	0·87	1·72	0·88	1·96	1·49	2·73	0·98	1·26
13	−1·24	1·68	0·28	0·89	0·49	0·72	0·89	2·45	1·52	2·93	0·85	2·26
14	0·05	1·47	0·66	1·36	0·85	1·04	1·37	2·14	1·16	2·93	1·00	2·29
15	−0·85	1·14	1·53	0·97	1·66	1·74	1·09	1·59	0·68	2·22	0·80	1·63
16	−0·66	1·29	1·01	1·78	1·35	2·63	1·08	1·54	0·31	1·28	0·46	0·86
17	0·38	0·39	0·99	2·51	−0·01	2·94	1·62	2·31	−0·27	0·32	0·30	0·70
18	0·99	0·44	0·79	2·93	0·29	2·34	1·68	3·10	−0·18	−0·52	0·46	0·99
19	−0·05	1·18	0·59	1·30	−0·13	0·50	1·48	3·17	0·28	−0·57	0·85	0·86
20	0·57	1·54	0·43	0·56	−0·45	−1·14	1·20	2·83	0·75	0·10	0·62	0·98
21	0·10	0·45	0·17	0·13	−0·26	−1·49	0·55	2·11	1·16	1·41	0·43	1·23
22	0·35	0·38	0·65	0·54	0·46	−0·36	−0·05	1·16	1·99	2·65	0·53	1·38
23	−0·47	0·64	0·90	0·97	1·45	1·11	0·13	0·02	1·63	3·55	0·60	0·96
24	0·11	0·35	1·01	1·41	2·07	2·44	0·05	−0·56	−0·01	3·36	0·78	0·49
25	−0·08	0·91	1·11	2·26	2·10	3·68	0·19	−0·27	0·08	2·67	0·78	0·99
26	−0·10	0·01	1·05	2·31	1·90	4·38	0·68	0·78	0·68	1·56	0·68	1·81
27	−1·29	0·43	0·47	2·09	2·69	4·06	1·13	1·45	0·62	0·97	0·79	2·06
28	0·09	2·10	0·55	1·08	1·57	2·82	1·20	1·83	0·00	0·97	0·71	1·30
29	0·07	1·21	..	..	1·33	1·98	1·37	1·16	0·45	1·61	0·24	0·51
30	0·69	0·18	..	..	1·02	2·30	1·66	2·51	1·79	2·64	0·08	0·49
31	0·38	2·38	..	..	0·09	2·71	..	..	2·10	3·42	..	..

Date.	July.		August.		September.		October.		November.		December.	
	I.	K.	I.	K.	I.	K.	I.	K.	I.	K.	I.	K.
	°	°	°	°	°	°	°	°	°	°	°	°
1	0·40	0·59	0·94	1·28	0·07	1·90	0·70	1·00	0·83	2·02	−1·05	1·19
2	0·28	0·60	0·40	1·25	1·24	1·84	0·80	1·15	1·54	3·00	−0·53	1·68
3	0·11	0·32	0·09	1·04	1·08	1·95	0·72	1·58	0·81	2·97	−0·64	1·47
4	0·24	0·27	0·18	0·64	1·06	1·88	0·63	1·61	1·29	1·96	−0·98	1·47
5	0·44	0·40	0·15	−0·15	0·80	1·33	0·89	1·68	−1·91	2·09	−1·05	1·77
6	0·37	0·62	−0·04	−0·26	0·72	0·86	1·11	1·99	−1·19	2·37	−0·83	1·57
7	0·41	0·86	0·41	0·11	0·82	1·61	1·14	2·68	−0·85	2·61	−0·55	0·88
8	0·58	0·91	0·81	0·89	1·27	2·54	1·52	3·28	−1·54	2·45	−0·49	0·24
9	0·09	0·84	0·66	1·40	1·09	3·35	1·67	3·17	−1·44	2·29	−0·59	0·90
10	0·23	0·43	0·85	1·44	1·45	2·75	1·51	2·41	−1·34	2·69	−0·78	2·31
11	0·38	0·30	0·68	1·54	1·59	2·23	1·32	1·43	−1·44	2·56	−1·04	3·53
12	0·39	0·20	0·38	1·12	1·50	1·75	0·94	0·78	−1·28	2·78	−1·77	4·23
13	0·29	0·83	0·13	0·92	0·86	1·61	0·54	0·66	−1·77	2·44	−2·40	4·09
14	0·52	1·00	0·61	0·27	0·83	1·42	0·40	1·08	−1·16	1·98	−2·09	3·12
15	0·15	0·93	0·59	0·37	0·92	1·44	0·74	1·78	−0·82	1·11	−1·32	0·82
16	0·31	0·26	0·78	0·96	0·89	1·83	1·03	2·34	−0·93	0·93	−0·31	−1·53
17	0·88	0·12	1·34	1·91	0·99	2·01	1·02	2·05	−0·83	1·42	0·43	2·19
18	0·86	0·37	1·35	2·51	0·99	1·99	0·90	1·06	−0·63	2·15	0·49	−1·49
19	0·42	0·89	1·00	2·41	1·04	1·76	0·65	0·42	−1·16	2·33	0·94	0·00
20	0·13	0·91	0·92	2·08	1·11	1·82	0·58	0·76	−1·14	2·10	0·49	0·40
21	0·08	0·52	1·03	1·52	1·10	1·95	0·70	1·63	−1·08	1·74	0·40	0·19
22	0·08	0·09	0·95	1·39	0·93	1·77	0·58	2·22	−1·21	1·76	−0·75	0·82
23	0·10	0·11	0·69	1·72	0·87	1·61	1·02	2·19	−0·98	1·28	−0·74	2·86
24	0·33	0·15	0·70	1·81	1·07	1·63	1·46	2·44	−0·32	0·70	−1·03	3·25
25	0·13	−0·06	0·57	1·47	1·07	2·13	1·40	2·24	−0·50	0·16	−1·37	2·91
26	0·34	0·32	0·57	0·58	1·07	2·47	0·92	1·93	−0·19	0·34	−2·03	2·65
27	0·43	0·97	0·20	0·56	1·25	2·47	1·04	0·97	−0·42	0·83	−1·61	2·69
28	0·72	−0·86	0·52	0·72	1·39	2·28	0·67	0·59	−0·26	1·58	−1·34	..
29	0·60	0·98	0·93	1·14	1·24	1·78	0·47	0·46	−0·53	−0·96	−1·29	..
30	0·38	1·01	1·15	2·30	0·91	1·27	0·24	−0·38	−0·58	1·13	−0·95	..
31	0·62	1·32	0·95	2·34	..	..	0·06	0·88	..	..	−0·67	..

TABLE IV.

Shows the apparent anomalies, the dates on which they occur at each place, and the greatest difference.

Places.	1—5.		6—10.		11—15.		16—20.		21—25.		26—31.		Number of disturbed days.
	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	
January.		°		°		°		°		°		°	
St. Petersburg	..	..	4—15	1·57	..	..	..	..	..	..	..	..	1
Copenhagen	..	..	..	..	..	..	..	..	20—22 24	0·12 0·01	26 28—31	0·01 0·20	4
Dantzig	..	..	..	..	..	..	..	..	20—24	0·60	..	..	1
Berlin	..	..	..	..	..	..	..	..	19—25	0·83	31	0·05	2
Leipzig	..	..	..	..	..	..	..	..	..	..	29—31	0·31	2
Breslau	..	..	..	..	..	..	..	..	20—26	0·64	..	..	1
Vienna	..	..	..	..	..	..	..	..	21—24	0·37	26—27	0·10	2
Cracow	..	..	..	..	..	..	17	0·11	21—23	0·82	27—31	0·97	3
Hohenpeissenberg	4—7	0·46	..	..	..	..	16—18	0·14	21—23	0·27	29—31	0·30	4
Kremsmünster	3	0·03	..	..	..	..	16—18	0·09	21—23	0·11	27 31	0·05 0·10	5
Munich	3—4	0·08	..	..	..	..	15—22	0·74	..	..	26—31	1·13	3
Milan	..	..	..	..	12	0·03	19	0·02	..	..	28	0·03	3
Rome	..	..	9	0·01	14—17	0·16	..	..	20—25	0·38	27—29	0·22	4
Greenwich	..	..	..	..	14—16	0·22	20—21	0·20	..	..	27—31	0·32	3
Chiswick	1 4	0·56 0·03	..	..	14—16	0·26	19	0·04	..	..	27—28	0·04	5
Helder	3—4	0·19	..	..	..	..	..	..	20—22	0·44	26—30	1·33	2
Utrecht	4—6	0·41	..	..	..	..	..	..	19—29	1·43	31	0·76	2
Brussels	1 4—7	0·40 0·30	..	..	15—17	0·20	20—21	0·20	..	..	..	..	3
February.													
St. Petersburg	4—7	0·36	..	..	12—18	0·79	..	..	22—23	0·10	..	..	3
Copenhagen	1—3	0·23	5—14	0·22	..	..	17—20	0·08	..	..	..	..	3
Dantzig	1—10	0·60	..	..	..	..	19—22	0·30	..	..	27—28	0·36	3
Berlin	1—9	0·45	..	..	12—14	0·12	17—19	0·17	..	..	27—28	0·11	4
Leipzig	1—3	0·25	7 9—10	0·01 0·11	..	..	18—23	0·45	..	..	..	..	4
Breslau	..	..	6—16	1·10	..	..	19—20	0·11	..	..	27	0·01	3
Vienna	..	..	8—15	0·50	..	..	19	0·03	..	..	27—28	0·27	3
Cracow	1—15	1·75	..	..	..	..	19—20	0·16	..	..	..	..	2
Hohenpeissenberg	1—20	1·23	..	..	..	..	..	..	21—25	0·33	26—28	0·40	3
Kremsmünster	..	..	5—7	0·10	11—15	0·29	18—20	0·08	..	..	28	0·22	4
Munich	1—2	0·61	8—15	0·93	..	..	19	0·02	..	..	..	..	3
Milan	2	0·08	..	..	..	..	..	..	..	..	..	..	1
Rome	2—5	0·05	7 9	0·05 0·02	11—15	0·53	..	..	20—22	0·17	26—27	0·04	6
Greenwich	1—4	0·32	8—21	0·93	..	..	..	..	23—28	0·13	..	..	3
Chiswick	2	0·01	7—24	1·40	..	..	..	..	..	..	..	..	2
Helder	..	..	6—28	4·50	.	..	..	..	..	..	..	..	1
Utrecht	1	0·61	6—15	3·77	..	..	17—25	1·10	..	..	28	0·12	4
Brussels	1 3	0·06 0·03	8—24	0·57	..	..	..	..	..	..	28	0·17	4
March.													
St. Petersburg	3	0·01	9—11	0·19	..	..	..	..	22—26	0·50	..	..	3
Copenhagen	5—6	0·06	..	..	9—15	0·19	20—21	0·06	..	..	..	..	3
Dantzig	1—2	0·44	5—12	0·40	..	..	..	..	23	0·04	29—30	0·04	4
Berlin	1 5	0·25 0·02	9—13	0·29	..	..	..	..	20—25	0·18	..	..	4
Leipzig	1—4	0·49	9—15	0·58	..	..	19—21	0·20	..	..	..	..	4
Breslau	1—2	0·04	..	..	10—14	0·45	..	..	..	..	26	0·06	3
Vienna	1—2	0·37	10—12	0·24	..	..	19—22	0·16	..	..	..	..	3
Cracow	2—4	0·22	..	..	10—16	0·65	..	..	..	..	..	..	2
Hohenpeissenberg	1—2	0·40	8	0·06	10—12	0·40	19—22	0·27	..	..	31	0·03	5
Kremsmünster	1—2	0·44	..	..	12	0·09	..	..	21—23	0·08	..	..	3
Munich	1—2	0·22	..	..	9—16	0·56	19—21	0·30	..	..	..	..	3
Milan	..	..	..	..	..	..	..	..	..	..	..	..	0
Rome	1—7	0·31	9	0·06	11—12	0·14	..	..	20—24	0·43	29	0·01	5
Greenwich	..	..	4—11	0·68	..	..	16—18	0·13	22—26	0·07	31	0·03	4
Chiswick	..	..	4—11	0·53	..	..	16—25	0·40	..	..	..	..	2
Helder	1—2	1·11	7—16	1·80	..	..	19—23	1·19	..	..	..	..	3
Utrecht	1—2	0·59	6—13	1·31	..	..	18—24	0·94	..	..	..	..	3
Brussels	1—2	0·50	5—13	0·67	..	..	18—23	0·40	..	..	..	..	3

TABLE IV.—*Continued.*

Places.	1—5.		6—10.		11—15.		16—20.		21—25.		26—31.		Number of disturbed days.
	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	
APRIL.		°		°		°		°		°		°	
St. Petersburg	..	..	7	0·07	..	..	..	..	..	..	25—28	0·18	2
Copenhagen	..	..	..	..	..	..	..	..	..	..	..	..	0
Dantzig	..	..	..	..	11	0·14	..	..	..	..	..	..	1
Berlin	..	..	..	..	..	..	..	..	25	0·02	..	..	1
Leipzig	..	..	10—11	0·05	..	..	..	..	..	..	27—29	0·19	2
Breslau	..	..	..	..	11—12	0·08	..	..	23	0·01	..	..	2
Vienna	..	..	..	..	..	..	..	..	..	..	..	..	0
Cracow	..	..	..	..	15—16	0·07	19	0·14	23—28	0·52	..	..	3
Hohenpeissenberg	..	..	9—12	0·56	..	..	..	..	22	0·03	..	..	2
Kremsmünster	..	..	9—11	0·30	..	..	16—17	0·03	..	..	..	..	2
Munich	..	..	9—18	0·74	..	..	..	..	..	..	29—30	0·14	2
Milan	..	..	..	..	..	..	..	..	..	..	..	..	0
Rome	1	0·04	7—12	0·79	..	..	..	..	21—23	0·40	..	..	3
Greenwich	1	0·15	8—10	0·80	..	..	16	0·02	..	..	..	..	3
Chiswick	..	..	7—14	0·76	..	..	..	..	23—25	0·13	..	..	2
Helder	..	..	8—12	1·68	..	..	17	0·51	22—30	0·72	..	..	3
Utrecht	..	..	9—13	1·35	..	..	16—18	0·58	22—30	2·51	..	..	3
Brussels	..	..	9—14	0·60	..	..	..	..	23	0·03	28—30	0·47	3
MAY.													
St. Petersburg	..	..	..	..	..	..	20—23	0·19	..	..	..	..	1
Copenhagen	..	..	..	..	..	..	..	..	..	..	..	..	0
Dantzig	7	0·10	..	..	..	..	..	..	..	..	..	..	1
Berlin	..	..	..	..	12—13	0·28	..	..	..	..	29—30	0·07	2
Leipzig	..	..	..	..	10—15	0·41	..	..	23—26	0·17	30	0·01	3
Breslau	..	..	..	..	10—16	0·57	..	..	25—27	0·56	..	..	2
Vienna	5	0·07	10—11	0·10	..	..	..	..	..	..	31	0·14	3
Cracow	..	..	..	..	14	0·09	..	..	25—28	0·48	31	0·07	3
Hohenpeissenberg	4—6	0·33	9—16	0·67	..	..	..	..	22—28	0·77	30—31	0·07	4
Kremsmünster	5	0·13	10	0·08	13—15	0·13	..	..	23—27	0·27	31	0·01	5
Munich	1	0·31	..	..	..	..	..	..	25—29	0·78	..	..	2
Milan	..	..	..	..	..	..	..	..	..	..	..	..	0
Rome	2—3	0·11	10	0·03	12—13	0·11	17—19	0·35	25—26	0·38	31	0·01	6
Greenwich	..	..	8—14	0·36	..	..	..	..	..	..	..	..	1
Chiswick	..	..	7—10	0·16	..	..	..	..	21—22	0·03	..	..	2
Helder	..	..	..	..	14—15	0·81	..	..	25	0·24	29 31	0·43 0·23	4
Utrecht	1—3	0·82	..	..	13	0·44	20	0·19	..	..	28—31	0·75	4
Brussels	1	0·46	..	..	14—15	0·20	19	0·04	..	..	26—27 31	0·30 0·03	5
JUNE.													
St. Petersburg	..	..	9—12	0·10	..	..	..	..	..	..	..	..	1
Copenhagen	..	..	..	..	..	..	17	0·01	..	..	29—30	0·23	2
Dantzig	..	..	..	..	..	..	18—19	0·13	23—24	0·10	..	..	2
Berlin	4—9	0·28	..	..	..	..	19—25	0·54	..	..	30	0·03	3
Leipzig	4	0·03	..	..	13—21	0·37	..	..	24—25	0·08	30	0·11	4
Breslau	5	0·05	9	0·02	13—22	0·66	..	..	24—26	0·14	..	..	4
Vienna	5—7	0·13	..	..	14—21	0·57	..	..	24	0·03	..	..	3
Cracow	1	0·22	6	0·09	9—12	0·25	20	0·01	24—30	0·52	..	..	5
Hohenpeissenberg	5—8	0·23	..	..	15—25	0·93	..	..	..	..	28—30	0·27	3
Kremsmünster	5—6	0·05	8—10	0·13	14—20	0·49	..	..	23—25	0·22	..	..	4
Munich	..	..	7—8	0·13	13—21	0·64	..	..	25—28	0·10	..	..	3
Milan	..	..	..	..	..	..	17—20	0·12	..	..	28—30	0·23	2
Rome	..	..	8—10	0·32	..	..	16—20	0·19	..	..	29—30	0·39	3
Greenwich	4—8	0·32	..	..	..	..	16—19	0·33	..	..	28—30	0·67	3
Chiswick	..	..	..	..	..	..	16—19	0·27	23—25	0·14	28—30	0·53	3
Helder	..	..	6—10	0·34	..	..	16—17	0·71	22—24	0·06	28—30	0·29	4
Utrecht	5—18	2·99	..	..	..	..	..	..	25	0·15	28—30	1·11	3
Brussels	..	..	9—11	0·10	15—19	0·26	..	..	23—30	0·90	..	..	3

TABLE IV.—*Continued.*

Places.	1—5.		6—10.		11—15.		16—20.		21—25.		26—31.		Number of disturbed days.
	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	
JULY.		°		°		°		°		°		°	
St. Petersburg	..	..	..	..	13	0·02	19	0·04	..	..	..	..	2
Copenhagen	1— 3	0·36	9—10	0·04	14	0·05	16—20	0·12	..	..	..	..	4
Dantzig	..	..	..	..	..	..	..	..	..	..	..	..	0
Berlin	1— 3	0·35	..	..	10—16	0·36	..	..	20—24	0·36	..	..	3
Leipzig	1— 2	0·23	9—11	0·16	..	..	16—17	0·16	..	..	30	0·01	4
Breslau	1— 3	0·29	..	..	10—19	0·51	..	..	..	..	..	..	2
Vienna	1— 3	0·23	..	..	10—13	0·33	16—17	0·06	..	..	..	..	3
Cracow	1— 5	0·68	..	..	10—18	0·48	..	..	..	..	..	..	2
Hohenpeissenberg	1— 2	0·53	8—18	0·86	..	..	..	..	..	..	..	..	2
Kremsmünster	1— 2	0·08	..	..	10—13	0·34	16—17	0·14	..	..	..	..	3
Munich	2	0·03	6— 7	0·10	10—12	0·24	..	..	..	..	..	..	3
Milan	..	..	8	0·01	..	..	..	..	..	..	29—31	0·27	2
Rome	1— 3	0·72	8—13	0·56	..	..	..	..	25	0·51	29—31	0·25	4
Greenwich	1— 3	0·43	6—11	0·58	..	..	..	..	..	..	..	..	2
Chiswick	1— 2	0·40	..	..	..	..	..	..	..	..	..	..	1
Helder	1— 2	0·47	..	..	..	..	..	..	..	..	..	..	2
Utrecht	1— 3	1·36	6 8	0·03 0·05	..	..	..	..	25	0·14	29—31	0·50	5
Brussels	1— 7	1·60	..	..	..	..	..	..	..	..	..	..	3
AUGUST.													
St. Petersburg	..	..	8— 9	0·11	..	..	17	0·03	..	..	29	0·01	3
Copenhagen	..	..	..	..	14—15	0·07	19	0·03	..	..	..	..	2
Dantzig	..	..	..	..	..	..	..	..	..	..	..	..	0
Berlin	5	0·06	9—10	0·10	14	0·01	..	..	24	0·05	30—31	0·07	5
Leipzig	1— 9	0·30	..	..	12—16	0·13	20—22	0·09	25	0·12	..	..	4
Breslau	..	..	8— 9	0·09	12—16	0·35	..	..	21—22	0·06	26—29	0·18	4
Vienna	..	..	..	..	12—15	0·26	..	..	..	..	..	..	1
Cracow	..	..	9—10	0·03	13—17	0·37	..	..	21—22	0·11	27—29	0·31	4
Hohenpeissenberg	..	..	..	..	9—16	0·94	..	..	..	..	27—31	0·57	2
Kremsmünster	3— 4	0·31	..	..	10—17	0·76	..	..	..	..	27—29	0·13	3
Munich	..	..	7—10	0·32	12—16	0·57	..	..	21—23	0·31	27—29	0·41	4
Milan	1— 8	0·58	..	..	10—13	0·10	..	..	..	..	..	..	2
Rome	1—18	0·16	..	..	..	..	..	..	..	..	..	..	1
Greenwich	..	..	..	..	12	0·27	..	..	23	0·07	25	0·01	3
Chiswick	..	..	..	..	14	0·13	18—19	0·13	..	..	25—28	0·37	3
Helder	..	..	..	..	..	..	17—21	1·29	25	0·02	..	..	2
Utrecht	1—16	4·69	..	..	..	..	18—22	0·26	25	0·07	31	0·22	4
Brussels	..	..	..	..	10—21	0·73	..	..	..	..	27—29	0·10	3
SEPTEMBER.													
St. Petersburg	..	..	..	..	..	..	..	..	..	..	..	..	0
Copenhagen	..	..	..	..	..	..	..	..	..	..	..	..	0
Dantzig	..	..	..	..	..	..	..	..	..	..	..	..	0
Berlin	..	..	..	..	..	..	..	..	..	..	..	..	0
Leipzig	..	..	6— 8	0·07	..	..	17—18	0·13	23—25	0·27	27	0·06	4
Breslau	..	..	8— 9	0·09	..	..	17—18	0·16	23—25	0·07	..	..	3
Vienna	..	..	..	..	..	..	18	0·10	24	0·03	..	..	2
Cracow	..	..	9—11	0·20	..	..	17—20	0·47	..	..	24—30	0·33	3
Hohenpeissenberg	..	..	..	..	..	..	15—19	0·73	22—24	0·20	28—30	0·07	3
Kremsmünster	..	..	..	..	..	..	17—19	0·27	24	0·03	28—30	0·14	3
Munich	3— 6	0·13	..	..	..	..	17—19	0·27	23—25	0·17	28—30	0·33	4
Milan	..	..	..	..	..	..	..	..	..	..	..	..	0
Rome	2	0·01	7— 9	0·24	..	..	16—17	0·11	22—25	0·04	30	0·49	5
Greenwich	2	0·01	6	0·01	13—16	0·12	..	..	23—25	0·24	..	..	4
Chiswick	3— 4	0·04	6— 8	0·14	..	..	16—18	0·40	22—23	0·07	28	0·04	5
Helder	4	0·13	..	..	..	..	16—17	0·03	..	..	25—30	0·82	3
Utrecht	2— 5	0·64	10	0·06	..	..	15—18	0·79	..	..	24—30	1·62	4
Brussels	4	0·03	8— 9	0·07	..	..	16—18	0·23	23—26	0·07	28—29	0·10	5

TABLE IV.—*continued.*

Places.	1—5.		6—10.		11—15.		16—20.		21—25.		26—31.		Number of disturbed days.
	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	Dates.	Difference.	
October.		°		°		°		°		°		°	
St. Petersburg	..	..	..	..	..	..	..	..	..	..	..	..	0
Copenhagen	..	..	..	..	..	..	..	..	..	..	..	..	0
Dantzig	..	..	..	..	..	..	..	..	..	..	..	..	0
Berlin	1— 2	0·06	6	0·14	..	..	..	..	..	..	31	0·06	3
Leipzig	..	..	..	..	..	..	17—19	0·32	..	..	..	..	1
Breslau	..	..	..	..	..	..	16	0·03	24—25	0·05	..	..	2
Vienna	..	..	..	..	..	..	..	..	..	..	..	..	0
Cracow	1	0·17	..	..	..	..	..	..	24	0·08	..	..	2
Hohenpeissenberg	..	..	4— 7	0·37	14—16	0·13	..	..	..	..	..	..	2
Kremsmünster	1— 2	0·40	..	..	..	..	..	..	..	..	..	..	1
Munich	1	0·27	..	..	..	..	..	..	..	..	31	0·03	2
Milan	..	..	..	..	..	..	..	..	..	..	..	..	0
Rome	1— 3	0·03	7	0·04	14	0·05	18—21	0·16	..	..	..	..	4
Greenwich	2— 3	0·09	10—11	0·06	..	..	18—21	0·22	..	..	31	0·30	4
Chiswick	..	..	10—11	0·16	..	..	..	..	21—23	0·20	30—31	0·30	3
Helder	..	..	..	..	12	0·05	17—19	0·33	..	..	..	..	2
Utrecht	5— 6	0·59	..	..	12	0·06	18—19	0·45	..	..	..	..	3
Brussels	..	..	..	..	..	..	18—19	0·07	24	0·03	31	0·37	3
November.													
St. Petersburg	4	0·01	..	..	..	..	..	..	..	..	29—30	0·09	2
Copenhagen	..	..	..	..	..	..	..	..	21—23	0·05	27—30	0·14	2
Dantzig	..	..	..	..	..	..	..	..	..	..	26—30	0·43	1
Berlin	1	0·11	9	0·01	..	..	..	..	..	..	28—30	0·25	3
Leipzig	..	..	..	..	..	..	..	..	22—30	0·44	..	..	1
Breslau	..	..	..	..	..	..	..	..	22—24	0·12	29	0·09	2
Vienna	..	..	..	..	15	0·03	..	..	..	..	..	..	1
Cracow	..	..	8	0·13	..	..	..	..	22—25	0·50	28—30	0·37	3
Hohenpeissenberg	..	..	6— 8	0·13	..	..	19	0·06	21—26	0·74	29—30	0·10	4
Kremsmünster	..	..	..	..	15—16	0·13	..	..	24—25	0·09	28—29	0·10	3
Munich	..	..	..	..	14—16	0·27	..	..	22—30	0·82	..	..	2
Milan	..	..	..	..	..	..	..	..	..	..	..	..	0
Rome	..	..	7— 8	0·05	12—14	0·18	..	..	22—27	0·18	..	..	3
Greenwich	1— 2	0·32	6	0·02	10—12	0·24	19—21	0·32	..	..	25—30	1·08	5
Chiswick	1	0·30	..	..	..	..	..	..	19—23	0·50	27—30	0·46	3
Helder	..	..	4— 7	0·66	14—16	0·57	..	..	22—28	1·20	..	..	3
Utrecht	3— 8	1·76	..	..	14—16	0·87	..	..	21—28	1·37	..	..	3
Brussels	1	0·33	..	..	..	..	15—17	0·23	21—30	0·77	..	..	2
December.													
St. Petersburg	..	..	..	..	12	0·03	..	..	20—27	0·87	..	..	2
Copenhagen	..	..	7— 8	0·03	..	..	..	..	24—26	1·08	..	..	2
Dantzig	1— 4	1·03	..	..	12—13	0·03	18	0·04	..	..	28—29	0·10	4
Berlin	1— 2	0·39	9—12	0·12	..	..	20	0·01	22—23	0·35	28—29	0·19	5
Leipzig	..	..	5— 8	0·14	12—19	0·44	..	..	..	..	..	..	2
Breslau	..	..	5— 7	0·18	14—16	0·10	..	..	..	..	31	0·08	3
Vienna	..	..	5— 7	0·17	..	..	16—17	0·10	..	..	..	..	2
Cracow	..	..	5—10	1·00	..	..	14—21	1·22	..	..	25—27	0·12	3
Hohenpeissenberg	..	..	4— 8	0·84	14—16	0·10	..	..	22—23	0·07	26 30—31	0·06 0·17	5
Kremsmünster	..	..	6	0·01	..	..	15—18	0·36	22—25	0·23	..	..	3
Munich	..	..	5—10	0·53	..	..	15—20	0·71	..	..	29—31	0·53	3
Milan	..	..	..	..	..	..	..	..	..	..	28	0·01	1
Rome	..	..	7— 9	0·20	16	0·06	18—20	0·21	23—28	0·33	..	..	4
Greenwich	1— 9	0·35	..	..	13—18	0·26	..	..	..	..	28—31	0·80	3
Chiswick	1—11	0·10	..	..	13—16	0·30	..	..	..	..	28—31	0·74	3
Helder	..	..	2—17	2·47	..	..	..	..	22—31	1·68	..	..	2
Utrecht	..	..	3—19	3·63	..	..	..	..	23	0·18	25—31	3·73	3
Brussels	1	0·26	5— 7	0·26	12—18	0·74	..	..	24	0·07	26—31	0·27	4

TABLE V.

Giving the epochs of the days of minimum and maximum temperature.

Place.	No. of Years.	Minimum.		Maximum.	
		Date.	Temp.	Date.	Temp.
St. Petersburg	118	19—31 Jan.	—10°20	20—29 July	18°32
Copenhagen	92	4—16 „	—1·10	21 July—4 Aug.	14·46
Dantzig	31	5—10 „	—3·80	25 „— 7 „	17·80
Berlin	110	6—11 „	—2·29	25 „— 1 „	19·47
Leipzig	64	5—14 „	—2·78	17 „—25 July	18·55
Breslau	80	6—13 „	—4·20	20 „— 5 Aug.	18·73
Vienna	100	4—11 „	—2·53	19 „— 5 „	21·47
Cracow	50	2—11 „	—5·34	19 „— 4 „	19·38
Hohenpeissenberg..	68	8—13 „	—3·33	19 „— 4 „	16·20
Kremsmünster	85	7—13 „	—4·12	18 „— 2 „	18·75
Munich	46	5— 9 „	—3·81	17 „— 3 „	17·68
Milan	110	5— 8 „	—0·14	14 „—20 July	24·10
Rome	40	29 Dec.–2 Jan.	8·60	17 „—24 „	29·51
Greenwich	50	4—11 „	1·93	12 „—11 Aug.	16·98
Chiswick	44	5— 9 „	2·20	3 „—13 „	17·90
Helder............	40	9—16 „	2·11	6 „—16 „	18·40
Utrecht	36	7—16 „	1·30	14 „—23 July	19·95
Brussels	38	8—12 „	1·20	13 „—24 „	19·30

TABLE VI.

Showing at how many of the eighteen places a given date seems to have a disturbed temperature.

Date.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
March	12	11	4	3	7	7	7	7	11	14	15	12	8	5	5	5	2	3	7	10	11	12	9	6	4	3	..	1	2	..	1
April	..	..	..	..	..	..	3	3	8	9	10	7	4	3	2	5	3	2	1	..	1	3	6	3	5	3	4	4	2	3	..
May	3	2	2	1	3	1	2	2	2	8	5	6	8	7	5	2	1	1	2	1	1	3	4	3	6	7	6	4	4	3	3
June	1	..	..	3	7	7	6	7	8	6	4	3	4	6	8	11	13	14	13	9	7	4	6	9	10	4	3	7	8	10	..
August ..	2	2	2	2	3	3	4	6	8	9	6	9	9	10	9	7	4	3	4	4	5	3	4	2	4	2	7	8	8	1	2
September	3	1	3	4	2	4	3	5	4	2	1	..	2	1	4	6	10	9	4	1	..	2	7	11	8	3	4	7	6	5	..
October ..	5	4	2	1	2	3	2	..	..	2	2	1	..	1	..	1	1	5	6	3	3	2	2	5	2	1	..	..	..	4	4
November	3	..	1	2	1	3	2	3	1	1	1	2	1	3	4	3	1	..	3	2	5	9	9	9	9	8	9	9	12	12	3
December	5	4	4	5	10	11	12	9	7	6	4	7	6	8	10	12	8	8	5	5	3	5	7	6	6	7	5	6	5	5	5

In May on the 10 and 13 eight of the seventeen places are 0°·1 or 0°·2 below the temperature of a previous day. There are scarcely more perturbations from May 10th—14th than from May 25th—29th, and less than from April 9th—13th, and June 15th—19th.

preferable to choose a shorter interval, I content myself now with the five-day intervals, also given at the foot of Table III., and separately, in order that any one may add as many of them together as he chooses. The reader may thus make use of these differences, or of those $v-p$, as may be preferred.

But I think it necessary to calculate in yet another way the same sort of differences for a much greater number of places, from the mean temperature of each day, and then compare them.

It is time, then, that in the first place we should calculate these temperatures for all places where long series of observations exist, because otherwise it cannot be shown that the false anomalies have disappeared ; but, on the other hand, a beginning must be made, and we cannot wait until posterity provides a sufficient number of stations. It is high time to call the attention of meteorologists to the necessity of knowing the temperature of each day,

and, by the mode I indicated, of finding the rate of rise and fall in every part of the year.

From the movements of the isotherms, and the increasing or diminishing distances between them under the same meridian, going faster at one meridian than at another, we see that the rise or fall of the temperature is not identical at all places for the arbitrary intervals of a month. We ought to know the same for every epoch of the year by such differences during each combination of five (or three) days, and by addition during a greater interval of time. Then we should see if this increase of temperature goes on continually from place to place, or if certain circumscribed regions show more marked differences than others.

If we have inquired into this and found, for instance, that in Bavaria or Hungary there is a well-indicated period of cold or of heat, the method of Prof. von Bezold may be applied with greater success. Then it will be time to inquire if the barometer and the winds show also changes which may appear irregular, but which, however, by that discussion, may be found to be in harmony with the disturbances of temperature, and to tend to the extinction of that difference; so we may find that there are no cosmical influences common to the whole surface of the earth, but local actions caused by the situation of mountains, by the melting of ice in the lakes of America, by the ice-drift along the east coast of that continent, and so forth, and still progressing from one place to another. By this method only do I think it possible to decide the point which I called so difficult in the beginning of this paper, viz. to state whether some particular days are too cold, or the preceding or following ones too warm for the season.

DISCUSSION.

Mr. C. Harding agreed with Dr. Buys Ballot that there would be much difficulty and a great amount of labour involved in using Bessel's formula for 365 terms, but could not help thinking that the formula used by Dr. Buys Ballot, although workable, was very complicated. The method of "smoothing" introduced by Sir G. B. Airy had not been referred to in the Paper. This process was eminently suitable when dealing with a large number of terms such as the means for each day in the year, and the labour was much less than that involved by using Dr. Buys Ballot's method.

Mr. Eaton said that it would be desirable to ascertain whether the St. Petersburg temperature observations had been taken on the same plan all through the series, as if not the results were possibly incorrect. There was reason to believe that the alleged increase of temperature of late years had no foundation in fact, and that a re-examination of the records of temperature in London in the latter part of last century, and nearly the first half of the present, would show that the method of exposure of the instruments then adopted had led to the mean temperature being estimated lower than the truth.

Mr. Symons believed that the method which Mr. C. Harding had attributed to Sir G. B. Airy was a very similar, if not exactly the same, process as that used by Mr. Bloxam in his book on *The Climate of Newport, Isle of Wight.* This system if pushed far enough would extinguish any irregularity and produce a smooth curve, which was hardly what was wanted, and he thought that perhaps the depressions of temperature, which one naturally looked for at certain periods of the year, had been masked by the method employed.

The President (Mr. Scott) said that Dr. Jelinek and Dr. Hann had reduced

the temperature observations for a long series of years at Vienna, and had arrived at the conclusion that there was practically no change in the climate of that city during those years.

CLOUD OBSERVING. By D. WILSON BARKER, F.R.Met.Soc.

[Read February 18th, 1885.]

THE study of upper cloud currents has lately been receiving much attention, but we are still far from possessing, in any way, a system of cloud classification which is satisfactory; and even when we do get a scientific classification it seems likely that we shall have some difficulty in obtaining observers who can devote proper time to the study of cloud forms. The importance of upper cloud observations can hardly be too much impressed on meteorologists, for it will only be by a careful study of the laws through which their movements are governed that we shall obtain a true insight into the movements of the upper atmosphere. Living as we do at the bottom of the aerial ocean, and only in the cases of isolated positions obtaining information from mountain tops, balloons and kites, it becomes important that as soon as possible observations should be taken in a more systematic form than has hitherto been followed. It will be my endeavour in this paper to offer a few remarks which may possibly aid in the study of upper cloud currents. Having been a close observer for some years, I have been struck by several peculiarities in the cloud formations, which when pointed out might help observers, and also those who undertake the reduction of the observations.

I must here refer to the Rev. W. Clement Ley's proposed scheme of cloud nomenclature,[1] and from the practical test I have given it I cannot recommend it too highly as fulfilling all conditions. But I am afraid that for the ordinary observer, who though willing to do all he can to forward meteorological interests, yet has not the time to study them properly, a more simple classification might be adopted, and is in fact very much to be desired. As it is now, there is a great deal of confusion amongst cloud observers, not only as to the particular names of clouds, but also especially with regard to their movements. A dual division is the simplest possible, and is really the natural division; for although composite clouds are often to be observed, the characteristic clouds are those to which we must look for forecasting the weather, which is practically the aim of meteorology.

The two divisions should be the "Stratiform" and "Cumuliform," the first being the more important. To the stratiform belong all the higher forms of cloud and a few of the lower, to the latter belong the typical cumulus cloud seen in the lower atmosphere. It will be noticed that when composite clouds are observed they indicate that the atmosphere is already disturbed, and so are only auxiliary to the other typical cloud observations.

[1] *Principles of Forecasting by means of Weather Charts*, by the Hon. R. Abercromby, p. 107.

The so-called cirro-cumulus cloud is a great stumbling-block to observers. It exhibits all kinds of phases, from the beautiful flecks arranged in lines, to the much lower and large irregular patches, and it commonly passes through all these states in a short time. This cloud partakes in no way of the cumulus type, but is essentially a stratiform cloud. Then, again, there is the cumulo-stratus, which is a cumulo-stratus only on the horizon; when seen overhead it will be observed that the cumulus and stratus are more or less detached.

It is utterly impossible that any accurate deductions can be made from the mass of cloud observations collected (more especially those from sea, which would be undoubtedly the most valuable) until it can be made certain that the observations both as to form and movement are more accurately taken than they are at present. Instrumental observations can, as a rule, be accurately made at sea, but more uniformity is required in noting wind forces and cloud forms. The former difficulty can to a certain extent be overcome by the employment of a suitable instrument; the latter will always depend more or less on the eye of the observer. Under these circumstances it is desirable that cloud observing should be simplified as much as possible, and that it should be impressed upon observers that unless an observation can be properly made, that is to say if there is the slightest doubt, it had better not be noted. Dividing the clouds into two divisions is a very simple measure, and the names at once suggest the forms of clouds to the observer. At the same time, no difficulty will, I think, be found in recording whether they were high, medium, or low clouds. Sufficient attention has not been paid to the direction of filature so commonly noticed in upper cloud formation, and which forms so valuable an index to their movements; for I think that it will be quite possible to determine the movement of the clouds if their direction of filature is noted. It will frequently be observed that cirri first become visible in a thread or wisp-like form either parallel to some part of the horizon, or else projecting upwards in a V-like shape, often eventually forming threads of cirrus over the sky. These should be at once noted, and the true bearing of the radiating points with the time of their first appearance recorded.

I beg to suggest the following symbols which I have been using for some time to indicate them. When first appearing in a V-form, and radiating in the South-west, this might be expressed as follows :—V SW. If they appear first as threads parallel to a certain part of the horizon, thus || W, indicating their first appearance on and parallel to the Western horizon; when the threads lie right-across the sky || SW to NE, indicating that the threads lie from South-west to North-east. It is very necessary that observations of the V point should be taken frequently, as though it generally seems to shift round in a definite direction, viz. from the Pole towards the Equator by West, yet this is not always the case.

The following table of observations taken by myself in various parts of the ocean has been prepared and tabulated so as to be comparable one hemisphere with the other. Column I. indicates the hemisphere; Col. II. the rhumb at which the V point was situated; Col. III. the observations, all

being tabulated and showing the angles of filature in points, + denoting the cloud coming from the right of the V point, – from the left; Col. IV. number of observations; and Col. V. mean angle of filature. This last column is not very satisfactory, the observations being too few for determining a proper angle.

TABLE OF OBSERVATIONS, WITH ANGLES OF FILATURE, ETC.

Poles to Equator by West.					Equator to Poles by West.			
Col. I.	Col. II.	Col. III.	Col. IV.	Col. V.	Col. II.	Col. III.	Col. IV.	Col. V.
				Pnts.				Pnts.
N.H.	N	....	0	..	WbS	0, 0, 0, 0, 0, 0	6	0
S.H.	S	0, 0, +6, +4	4	+2·5	WbN	{−9, +6, +1, +1, +1, 0}	6	0
N.H.	NbW	0, 0	2	0	WSW	0, 0	2	— 0
S.H.	SbW	{0, 0, 0, 0, +3, +1, 0}	7	+·57	WNW	{0, +2, 0, +6, 0, −6, −6, −2, −2, 0, 0, −2. 0, 0, 0, 0}	16	— ·5
N.H.	NNW	0, 0, −½	3	−·17	SWbW	{0, 0, 0, 0, +½, +4, +3, 0}	8	+ ·9
S.H.	SSW	0, 0, −6	3	−2·0	NWbW	{−4, 0, 0, −11, 0, 0, 0, 0, 0, 0, 0}	11	−1·4
N.H.	NWbN	−4, 0, 0	3	−1·3	SW	0, 0, 0, 0, 0	5	0
S.H.	SWbS	0, +1, 0, 0, 0	5	+ ·2	NW	{0, −½, 0, −6, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. 0, 0}	16	— ·4
N.H.	NW	0, 0, 0, 0, 0, 0	6	0	SWbS	0, 0, +8, +6	4	+3·5
S.H.	SW	{0, +5, +2, 0, +¾, 0}	6	+·46	NWbN	{0, 0, 0, 0, 0, 0, 0, −1, 0, 0}	10	— ·1
N.H.	NWbW	−4, −2, 0, 0, 0, 0	6	−1·0	SSW	0	1	0
S.H.	SWbW	0, 0, +1	3	+ ·3	NNW	0, 0, −2, 0	4	— ·5
N.H.	WNW	0, 0	2	0	SbW	....	0	..
S.H.	WSW	0, +2, +4, 0	4	+1·5	NbW	−2, −6, −6, −2	4	−4·0
N.H.	WbN	0, 0, 0	3	0	S	−2	1	−2
S.H.	WbS	0, 0, 0, 0	4	0	N	0	1	0
..	W	{0, −1, 0, +2, −4, 0, 0, 0, 0, 0, 0}	11	−·27	..	....	..	..
Poles to Equator by East.					**Equator to Poles by East.**			
N.H.	NbE	....	0	..	EbS	....	0	..
S.H.	SbE	....	0	..	EbN	....	0	..
N.H.	NNE	....	0	..	ESE	....	0	..
S.H.	SSE	+8	1	+8	ENE	0	1	0
N.H.	NEbN	....	0	.	SEbE	−2	1	−2
S.H.	SEbS	0, +5	2	+2·5	NEbE	....	0	..
N.H.	NE	....	0	..	SE	+8	1	+8
S.H.	SE	....	0	..	NE	....	0	..
N.H.	NEbE	....	0	..	SEbS	0	1	0
S.H.	SEbE	....	0	..	NEbN	0	1	0
N.H.	ENE	....	0	..	SSE	0	1	0
S.H.	ESE	0	1	0	NNE	....	0	..
N.H.	EbN	....	0	..	SbE	0, 0	2	0
S.H.	EbS	....	0	..	NbE	....	0	..
..	E	....	0	..	..	....	..	..

My observations tend to show that in most cases at the beginning of a depression the angle of filature is *nil*, and that the large angles occur when subsidiary depressions are passing over.

Frequently during squally weather with a Polar Westerly wind the sky before or after a squall will be completely covered with cirrus clouds in lines radiating from the squall centre; but in this paper none of these cases are noted, my endeavour being to get at a general law rather than a local one, squalls being comparatively much more affected by local causes than are the larger disturbances. In looking over cloud observations, an examination of the Weather Report will at once show whether squally conditions are prevailing or not, and as a rule this form of cirrus accompanies Polar Westerly winds principally.

The conclusion I come to, from a consideration of these facts, is that the actual normal motion of the cirro-filum cloud is along the line of filature, and that knowing the bearing of the V point the direction of its motion can be at once inferred.

In all cases I have observed the V point first formed in the point from which the cloud is coming, but it will frequently be noticed that threads first appear parallel to a certain part of the horizon, and in all sorts of positions between this and the central V point.

In addition to the regular movement of the upper clouds there will frequently be seen a motion of propagation at right angles to the lines of filature. At times the propagatory movement is so rapid as to give one the idea that the cloud is actually moving in that direction, and it is only by careful observation that the true movement can be discovered.

DISCUSSION.

Captain TOYNBEE said that the subject of the paper was very important, and thought that there was good work to be done by ordinary observers as well as by specialists. Ordinary observers may well be asked to record the apparent height of clouds, as well as their apparent speed—the terms "Slow," "Moderate," "Fast," being sufficient distinctions as to speed. He thought that it would be well to record regularly the direction from which the lowest clouds come, and their apparent speed at all land stations. This would be a good check on the error in wind direction and force produced by irregularities on the earth's surface. Specialists would do well to record the individual facts on which their statements are based. For instance, the paper spoke of the cirro-cumulus cloud as undergoing several changes in a short time. The particulars of a few such cases, giving the date, the position of the observer, the direction and force of the lower wind, the direction in which the cirro-cumulus was moving, &c. would add greatly to the value of such a statement. The much-abused cumulo-stratus cloud was, to his mind, evidence of the kind of work which specialists should endeavour to carry out. He had watched this cloud throughout a long sea life, and had found that when it appeared on the horizon it was followed by unsettled weather. It commonly occurred in the Tropics, on the equatorial verge of a Trade wind. Fault had been found with the name given to this cloud; it was, however, a matter of small importance to him by what name it was known, so long as seamen were able to distinguish it, and to benefit by the warning to be derived from it. If specialists would watch other well-defined clouds until they were able to establish for them as decided a character, he should adopt these with gratitude, and should not feel inclined to quarrel with the names they gave them. The division of clouds into two classes (lower

and upper), as given in the *Instructions for keeping the Meteorological Log*, together with their subdivision into "stratiform" and "cumuliform," seemed to meet the requirements asked for. Those *Instructions* ask observers to make a special note when a cloud seems to lie between the upper and lower regions. With regard to the mistakes sometimes made by captains in recording the names of clouds in the log, no doubt such mistakes do occur, as they do in all other observations; still, when the cloud observations over a given part of the sea are discussed, they clearly show that the truth predominates; for instance, in the *Charts of Meteorological Data for Nine Ten-degree Squares*, near the Equator in the Atlantic, published by the Meteorological Office, it would be seen that the percentage of nimbus ranges from 0 in the steady Trade to 30 or 40 in the Doldrums. The remarks accompanying these charts also show that the upper-cloud observations indicate the motion of the upper currents of air, where the Trade winds meet. If observers were impressed with the importance of cloud observations, he was confident that they would supply data for valuable results.

Mr. GASTER said that Mr. Barker was a most careful observer, and with respect to cirrus clouds had observed that their motions in relation to barometric depressions is the same in the Southern as in the Northern hemisphere; North being substituted for South and *vice versâ*. The attempt to reduce the number of clouds which can be observed to two types was, however, going a little too far. He hardly thought that even cirrus should be included under stratiform clouds. He noticed that Mr. Barker had fallen into the error of saying that the cumulo-stratus cloud was a cumulo-stratus only when on the horizon. If this were so the same cloud must be called by different names when viewed from different positions; for instance naming a cloud cumulus when seen on the horizon and (say) stratus when the same cloud passed overhead. The absolute necessity was that cloud observers shall be more thoroughly trained in their work than they are at present. A great deal of the confusion in cloud observing was due to errors arising from the position in which clouds were seen, the same cloud presenting different appearances from different points of view. (Mr. Gaster illustrated by means of some wool the different appearances of clouds when viewed from different situations.) Another source of error lay in the different powers of vision possessed by individual observers, a short-sighted person calling a cloud high or low which perhaps another person might describe as the reverse. Mr. Gaster then went on to speak of cumulo-stratus clouds, and remarked in this connection that a cumulo-stratus cloud did not consist of a patch of cumulus and another of stratus in close proximity to each other, but was an intermingling or union of the two types. In his opinion the great thing to do was to educate observers in cloud observing, and for this purpose a good text book with numerous diagrams showing clouds in all manner of positions and varying stages of development was very much needed.

Mr. ARCHIBALD agreed with Mr. Gaster in thinking the division of clouds into stratiform and cumuliform too rough unless supplemented by subdivisions. Stratiform clouds at the higher elevations, such as the cirrus, differed specifically, if not generically, from those at the lower elevations. He thought that if good measurements were made of the heights of clouds they would materially assist persons in recognising their species. Stratus could hardly be applied, as an unmodified term, to clouds which floated as high as 30,000 feet on the one hand, and as low as the earth's surface on the other. He agreed with those who suggested that the so-called cumulo-stratus cloud should be abolished from the list. He considered it simply represented a cumulus cloud floating amongst detached strati, and their physical conjunction was simply effected by the imagination of the observer.

Mr. C. HARDING was glad this paper had come before the Society. He drew attention to the confusion which in his opinion existed among observers with respect to cloud nomenclature. No one, when consulting the logs of ships passing through the "Trades," where the weather experienced is very constant, could help being struck by the different varieties of clouds which were entered as the predominant cloud; some logs giving stratus, others cumulus, cumulo-stratus, and so on, where in all probability one and the same form of cloud was intended.

Mr. WHIPPLE said it was not by any means easy to determine cloud heights,

except, perhaps, by the use of the Abney Photo-Nephograph. He thought it was very desirable that a cloud direction apparatus should be made for the use of observers. Mr. F. Galton had designed an instrument for this purpose for the Meteorological Council, but it was not very much used. Observers were supplied with instruments for accurately determining different atmospheric conditions, and differences of tenths of a degree on thermometers and of thousandths of an inch on barometers were being called into question, and yet they were left without any instrument for the purpose of making cloud observations except a few cloud mirrors. To conduce to uniformity cloud observations should be confined within a limited circular area, as the differences in the situation of the different stations was sometimes very great, one observer being situated in an elevated position where the view of sky is extensive, and another being perhaps confined to the view obtained from a street or other similar situation. He certainly agreed with Mr. Gaster that a book with copious illustrations of the varying aspects of cloud forms was very much needed in order to afford instruction to observers.

Mr. SYMONS remarked that the idea of limiting the area of cloud observation to 60° around the zenith was a rather old one. He thought much might be learned regarding cloud formation by means of photography; and especially from a series of photographs of a cloud at different angles and elevations, if it were possible to obtain such photographs.

THE PRESIDENT (Mr. Scott) said that the difficulty was not so much in photographing a cloud, but in recognising its form when photographed.

Mr. BARKER, in reply, said that he had frequently watched the high, fine flecks fall and go through other forms in the lower strata. Regarding Mr. Gaster's remarks, he said that in the case of cumulo-stratus in the zenith this would be recorded as two forms, while that on the horizon as seen by another man would be described as one. He maintained that the term cumulo-stratus was misleading, and might be dispensed with. He felt certain that the cirrus cloud partook of the stratiform nature, but its formation in the high regions may be different from that of stratus in the lower regions, as it was affected to a great extent by electrical action. He did not wish to limit the number of varieties of clouds, but in proposing two principal divisions he thought that when once observers had got drilled into distinguishing these forms they would be better prepared for the varieties. Too much attention had been hitherto paid to the actual form of the cloud, whereas more notice ought to be taken of the causes which produced clouds of certain forms. He had generally found persons could judge whether a cloud was floating at a high, medium, or low level. He could not well see how the V-shape could appear as 'end on,' as one of the speakers had remarked, because the V-shape was the effect of perspective, the clouds lying in parallel bands and at an equal altitude.

He had ventured to read this short paper in the hope that the subject of clouds would be taken up a little more freely, as he felt confident that cloud observations were valuable adjuncts to instrumental observations, more especially in isolated positions. What we wanted to arrive at was general atmospheric laws, and this would never be until a more extended system of cloud observations was in existence.

A SUGGESTION FOR THE IMPROVEMENT OF RADIATION THERMOMETERS. By WILLIAM FORD STANLEY, F.R.Met.Soc., F.G.S.

[Read February 18th, 1884.]

IN a valuable paper[1] by Mr. Whipple, read before this Society in December 1883, a careful investigation is made into the causes of variation of the readings of the black-bulb thermometers *in vacuo*. From this paper it is

[1] *Quarterly Journal*, Vol. X. p. 45.

clear that these instruments, made to similar dimensions, of the same materials, and of similar construction, give very great differences in the temperatures they register. Indeed the circumstances of manufacture are found by experience to be so critical, that it is impossible to reproduce similar instruments, or even to produce more than an arbitrary standard for their comparison. It is further a question whether the black-bulb thermometer *in vacuo* will, under any condition, register the radiation force of the sun's heat as it impinges on the surface of the earth even approximately. One thing is certain, that in any space enclosed by transparent media placed in direct sunshine and enclosing a dark body, heat will generally accumulate. This experience is made use of in our greenhouses. Melloni's experiments show that a surface of clear glass reflects one-tenth of the heat radiated upon it. In the black-bulb thermometer, therefore, the bulb being placed in the focus of a mirror formed by the back interior surface of its case, heat rays are reflected from this mirror to this extent per unit of surface, so that the heat registered by the black-bulb thermometer must be quite arbitrary, depending greatly upon the size of the enclosing case.

In a radiation thermometer exhibited before this Society on February 21st, 1877,[1] by Capt. E. Bourke, R.N., it was shown that by embedding one-half of the surface of the bulb of the jacket of an ordinary black-bulb thermometer in black cotton wool, the heat registered was considerably increased, the difference Capt. Bourke stated amounting in one particular case to as much as 68° F. above the dry-bulb thermometer in the shade. By experience of the difference between shade and sunshine temperatures upon our bodies, we are fully convinced that the difference is not so great as any of these instruments indicate.

The suggestion I have to offer for the radiation thermometer is that it shall indicate the amount of heat radiated by the sun upon a metal ball of a certain size, this being an object easy of uniform reproduction by mechanical means. In my experiments I made three hollow copper balls, which were cast with ordinary filed cores, and were of different weights (I found that the thickness of these balls within wide limits made very little difference in the temperature they indicated). These balls were turned to exact external diameter of 1·4 ins., having similar necks for the insertion of thermometers. The surfaces were oxidised by heating, to resemble the oxidation produced by the atmosphere. In each of these balls I inserted a similar thermometer, closing the neck, just sufficiently to keep it steady, with cotton thread soaked in paraffin. The three thermometers, thus enclosed in the metal balls, when exposed to sunshine and placed at 2 ins. above a piece of black board, appeared to register exactly alike under similar conditions. Of course, having no transparent medium to entrap the sun's heat, they did not register nearly so high as the ordinary black-bulb thermometer. The experiments for three summer months gave from 6° to 11° difference between the sun and shade. Afterwards (as the board collected dust) I arranged one of these

[1] *Quarterly Journal*, Vol. III. p. 365.

thermometers upon a piece of black enamelled slate placed at an angle of 45°, but as this was in the autumn, I have not had opportunity to make a sufficient number of observations to test its special merits. With the metal bulb the heat accumulates in a certain degree, so that this gives a kind of mean radiation temperature, but possibly it thereby gives a more valuable record than if it registered a transient gleam of sunshine only.

In testing the thermometer mounted on black enamelled slate against my cumulative temperature clocks, of which I gave a description in February 1877,[1] I found that the mean excess of temperature registered by the metal bulb was roughly about 2·5 times that of the clocks. In this experiment one of the clocks was exposed to sunshine, whilst the other was shaded. The clocks are in leaden cases about 1 ft. square and 4 ft. high, placed in an open space. They have, therefore, three sides top and bottom exposed to the mean shade temperature when the sun shines directly on the southern side. By measurement and calculation I found for one hour (noon to 1 p.m.) that about one-fifth of the surface was exposed to direct sunshine. So that I consider that for this time the direct heat derived from the sun's radiation upon a surface perpendicular to his rays in excess of the mean temperature was about five times that registered by the temperature clock. The metal-bulb thermometer, mounted on black enamelled slate, would, therefore, register about half the radiated heat which would fall upon a plane surface of a neutral colour directly exposed to the sun's rays. I estimate as such a neutral colour that of the oxidised leaden surface of the clock case.

The reflecting surface of blackened wood or slate must necessarily introduce quite arbitrary conditions, but these arbitrary conditions are almost impossible to be avoided. If the metal bulb were suspended, the thermometer stem being shaded and exposed to mean radiation on all sides, then as the great circle of the sphere is exactly one-fourth the area of its surface, the instrument would register exactly one-fourth of the excess of the sun's direct radiation; but we must decide previously upon the nature of the reflecting surface to be placed beneath it, for it would naturally affect the resulting temperature. Take, for example, grass as the reflecting surface—this varies in colour, texture and temperature (as upon a frosty morning); all of which qualities affect the results. The above suggestions are therefore proposed only as an approximate means of registration, somewhat more exact than any at present in use.

DISCUSSION.

Rev. F. W. Stow, in a letter to the Secretary, said :—"I am convinced by Mr. Whipple's experiments that the chief cause of discrepancy in the readings of Solar Radiation Thermometers is the unequal thickness of lamp black. It is above all things essential that the surfaces exposed to radiation should be similar. Can this be done with lamp-black? I will not say that it cannot, for the first instruments made on my plan (*i.e.* having the stem as well as the bulb blackened) agreed much better than more recent ones. They were principally, but not all, made by one maker, and at or about the same time; and probably also a tolerably

[1] *Quarterly Journal*, Vol. III. p. 352.

equal amount of black was put on. But I think it would be well if the Society were to make experiments with a view to obtaining in all instruments a surface on the bulb and stem near the bulb possessed of equal radiating power. There is black glass of which some instruments were made long ago. Not being dull it reflects heat, and would give a considerably lower temperature than lamp-black. Still, if it were found to give nearly the same result in all instruments the lower temperature would be no drawback, as in any case the temperature indicated is not of any absolute importance in itself. Could this black glass be ground or roughened in any way so as to make it dull, either by acids or in any other way? If so, I think we should have a good surface; and if the instrument makers would agree to make the bulbs and jackets as nearly as possible of one size, then I think the causes of discrepancy would be brought to a minimum. Suppose the Society, in conjunction with the Scottish Meteorological Society, were to recommend a particular size and method of construction, we should know what was meant by the amount of radiation."

Mr. Whipple said that he had been working at the subject of black-bulb thermometers since his last paper, referred to by Mr. Stanley, with the object of discovering what effect the size of the jackets had on the temperatures registered by the thermometers. The results of the experiments showed that the size of the jackets had little or no effect on the differences in registration of the thermometers. When bringing the paper containing the results of these observations before the Kew Committee, previous to presenting it to the Royal Meteorological Society, Mr. de la Rue suggested that the differences observed between the thermometers might be due to the method employed in obtaining the vacuum and also to the degree of exhaustion attained, and offered to test the vacua and also to re-exhaust the thermometers. This Mr. de la Rue had done for two instruments, and on comparing the thermometers again after the new exhaustion, they were found to read 20° higher than before. The makers of these very thermometers had stated that they had been previously exhausted as perfectly as possible.

The President (Mr. Scott) inquired what method Mr. de la Rue employed for obtaining his vacuum.

Mr. Whipple replied that Mr. de la Rue employed chemical means for this purpose.

Mr. Symons mentioned different improvements and alterations made in solar thermometers since they were first invented, and then went on to describe an apparatus used by Mr. Southall at Birmingham for registering the sun's heating power, and also the modification thereof employed by Col. Ward. He thought Mr. Stanley's thermometer a very ingenious arrangement, and an improvement on the instruments ordinarily used for measuring solar radiation, as it was low in price, easily manageable, and readily comparable.

Mr. Stanley thought that Mr. Whipple's statements helped to strengthen his paper, as it appeared to be certainly a very difficult matter to get satisfactory results from the records of Black-bulb Thermometers *in vacuo*. This form of instrument had the advantage of being both cheap and more comparable than the solar radiation thermometer now used.

Mr. Whipple asked whether the oxidisation of the metal ball would be interfered with by atmospheric conditions such as existed in manufacturing districts.

Mr. Stanley stated that the oxidisation of the ball would be rather increased than diminished by the action of the atmosphere, but the change in 20 years or so would not be great.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

January 21st, 1885.

Annual General Meeting.

Robert H. Scott, M.A., F.R.S., President, in the Chair.

Mr. W. F. Stanley and Mr. T. Wilson were appointed Scrutineers of the Ballot for Officers and Council.

Mr. SYMONS read the Report of the Council and the Balance Sheet for the past year (p. 73).

It was proposed by the PRESIDENT, seconded by Dr. TRIPE, and resolved :—
"That the Report of the Council be received and adopted, and printed in the *Quarterly Journal* of the Society."

It was proposed by Prof. ARCHIBALD, seconded by Mr. PEEK, and resolved :—
"That the best thanks of the Royal Meteorological Society be communicated to the Council of the Institution of Civil Engineers for having granted the Society free permission to hold its Meetings in the rooms of the Institution."

It was proposed by Mr. BREWIN, seconded by Mr. MELLISH, and resolved :—
"That the thanks of the Society be given to the Officers and other Members of the Council for their services during the year."

"It was proposed by CAPTAIN TOYNBEE, seconded by Mr. MAWLEY, and resolved :—"That the thanks of the Society be given to the Standing Committees and to the Auditors ; and that the Committees be requested to continue their services till the next Council Meeting."

The PRESIDENT then delivered his Address. (This will be printed in the next No. of the *Quarterly Journal.*)

It was proposed by Mr. LAUGHTON, seconded by Dr. MANN, and resolved :—
"That the thanks of the Society be given to the President for the ability and courtesy displayed by him in the Chair during the past year, and for his Address, and that he be requested to allow it to be printed in the *Quarterly Journal* of the Society."

The Scrutineers declared the following gentlemen to be the Officers and Council for the ensuing year, viz. :—

President.

ROBERT HENRY SCOTT, M.A., F.R S., F.G.S.

Vice-Presidents.

WILLIAM MORRIS BEAUFORT, F.R.A.S., F.R.G.S.
JOHN KNOX LAUGHTON, M.A., F.R.G.S.
EDWARD MAWLEY, F.R.H.S.
CHARLES THEODORE WILLIAMS, M.A., M.D., F.R.C.P.

Treasurer.

HENRY PERIGAL, F.R.A.S.

Trustees.

HON. FRANCIS ALBERT ROLLO RUSSELL, M.A.
STEPHEN WILLIAM SILVER, F.R.G.S.

Secretaries.

GEORGE JAMES SYMONS, F.R.S.
JOHN WILLIAM TRIPE, M.D., M.R.C.P.ED.

Foreign Secretary.

GEORGE MATHEWS WHIPPLE, B.Sc., F.R.A.S.

Council.

EDMUND DOUGLAS ARCHIBALD, M.A.
GEORGE CHATTERTON, M.A., M.Inst.C.E.
JOHN SANFORD DYASON, F.R.G.S.

HENRY STORKS EATON, M.A.
WILLIAM ELLIS, F.R.A.S.
CHARLES HARDING,
RICHARD INWARDS, F.R.A.S.
BALDWIN LATHAM, M.Inst.C.E., F.G.S.
ROBERT JOHN LECKY, F.R.A.S.
WILLIAM MARCET, M.D., F.R.S., F.C.S.
CUTHBERT EDGAR PEEK, M.A., F.R.A.S., F.R.G.S.
CAPT. HENRY TOYNBEE, F.R.A.S.

FEBRUARY 18TH, 1885.

Ordinary Meeting.

ROBERT H. SCOTT, M.A., F.R.S., President, in the Chair.

HENRY BROOKS BAKER, M.D., 726 Ottawa Street, Lansing, Michigan, U.S.A.;
SAMUEL DIXON, Ridge Cottage, Marple;
ROBERT FOSTER, The Quarries West, Clifton Road, Newcastle-on-Tyne; and
BENJAMIN OWEN MEEK, F.L.S., F.R.M.S., M.R.C.V.S., Swinley Hall, Wigan,
were balloted for and duly elected Fellows of the Society.

The following Papers were read, viz.:—

"THE ANOMALIES IN THE ANNUAL RANGE OF TEMPERATURE. HOW TO DETECT." By DR. C. H. D. BUYS BALLOT, LL.D., Hon. Mem. R. Met. Soc. (p. 104.)

"CLOUD OBSERVING." By D. WILSON BARKER, F.R.Met.Soc. (p. 119.)

"A SUGGESTION FOR THE IMPROVEMENT OF SOLAR RADIATION THERMOMETERS." By WILLIAM FORD STANLEY, F.R.Met.Soc., F.G.S. (p. 124.)

CORRESPONDENCE AND NOTES.

THE METEOROLOGICAL RESULTS OF THE LADY FRANKLIN BAY EXPEDITION.[1] By LIEUT. A. W. GREELY, U. S. Army.

THE general interest in the scientific work of most Polar Expeditions has been seriously affected by the long delay which necessarily occurs in the publication of the records and results. With the permission and concurrence of Gen. W. B. Hazen, Chief Signal Officer, I take pleasure in giving, as far as I can at present, a brief summary of some of the scientific results of the Lady Franklin Bay Expedition.

The following table (p. 130) of monthly means has been compiled from three years' observations,—1875-6 and 1881-83.

The barometrical observations show atmospheric changes which, I believe, are common to the region within the Arctic Circle, north of America at least. The marked maximum in April gives way rapidly to the principal minimum in July; to be followed by a secondary maximum in November, and a less marked minimum in January or February.

The hourly barometric observations are of special interest, as tending towards a final solution of the question whether or not the regular diurnal variation observed in lower latitudes also occurs near the poles. Buchan, noting the fact that the range at St. Petersburg and Bosekop is but about ·012 in., remarks, "And in

[1] *Science*, Vol. V. p. 309.

Months.	Barometer reduced to mean Sea-Level.	Tempera-ture.	Rainfall (two years only).
	ins.	°	ins.
January	29·756	—38·3	·42
February	·779	—40·1	·13
March	29·962	—28·3	·45
April	30·175	—13·6	·17
May	30·021	14·1	·40
June	29·852	32·7	·18
July	·725	37·1	·66
August	·787	33·8	·38
September	·749	15·8	·35
October	·925	— 8·9	·24
November	·971	—23·3	·20
December	29·830	—28·1	·30
Year	29·878	—3·9	3·88

still higher latitudes, at that period of the year when there is no alternation of day and night, the diurnal variation probably does not occur."

The first year's observations at Fort Conger satisfied me that such diurnal variation does occur in very high latitudes, and my opinion was confirmed by subsequent observations. Reductions made several months before the station was abandoned, from nearly five hundred days' continuous observation, showed a range of ·0099 in. The primary maximum occurs at 5 a.m., Washington Mean Time (which is 53 mins. slower than local time), followed by the primary minimum at 1 p.m. The secondary maximum and minimum took place at 6 p.m. and midnight respectively. To determine whether the presence or absence of the sun affected the fluctuation, I calculated separately the means of the days of continual darkness and of continuous sunlight up to May 1st, 1883. The diurnal fluctuation was substantially the same, and the critical hours were identical in the arctic night and in the polar day.

The absolute range of the barometer observed was 2·032 ins.—from 31·000 ins. April 9th, 1882, to 28·968 ins. February 19th, 1883. It is interesting to note that the minimum pressure for the year 1882-83 at Godthaab and in Spitzbergen occurred respectively one day earlier and three days later than at Fort Conger. The barometer at Godthaab touched the unusually low point of 27·890 ins.

The mean annual temperature (—3°·9) is the lowest on the globe, being 1°·4 below that deduced for Van Rensselaer Harbour from Kane's observations. It quite disposes of the theories of a warmer climate as the pole is approached. The mean maximum at Fort Conger agrees with that of other arctic stations in general, occurring in July; and the monthly mean gradually declines to the minimum in February. This month, I think, is generally the coldest at arctic stations; and when the lowest mean has been noted in January (or occasionally in March), I believe a series of years would change it to February. The lowest monthly mean (—46°·5), for February 1882, must give way, however, to that of Werchojansk (on the Lena), from which the following means are reported:—December —50°·3, January —56°, and February —53°. The highest monthly mean was that of July 1883, 37°·2. The absolute range of temperature was 115°·1 (—62°·1 February 3rd, 1882, to +53° June 30th, 1882).

The amount of rain and melted snow was 3·95 ins. the first, and 3·82 ins. the second year, irregularly distributed throughout the year. This small amount of precipitation may explain the non-glaciation of the adjacent country. I believe the precipitation in the interior to be less than at Fort Conger.

The wind resultants are as follows:—first year, S 61°·4 E, 7,594 miles; second year, S 67°·3 E, 6,437 miles. The wind was more Southerly from 2 to 4 p.m. inclusive than at other hours during the first year, and from 11 a.m. to 2 p.m. the second year.

The mean tidal establishment was determined by me at Fort Conger from two years' observations on a fixed gauge, as follows:—

High water (1,314 tides) 11h. 33·9m.
Low „ (1,314 tides) 17h. 45·7m.

Complete series of high and low waters for two years, with regular hourly readings of the tide for one year at Fort Conger, have been placed in the hands of Mr. Schott. These observations, with supplementary simultaneous readings at Capes Sumner, Beechy, Craycroft, Leebi, and at Repulse Harbour, added to Bessel's and Nares' observations, will, I trust, enable tidal experts to determine the co-tidal curves for Lincoln Sea, and Robeson and Kennedy Channels.

The temperature of the surface sea-water was carefully observed from October 1882 to June 1883. The temperature fell steadily from a mean of 29°·2 in October to 29°·0 in December, and then rose steadily to 29°·4 in June. The ebbing tide (to the north) was from 0°·1 to 0°·2 colder than the flowing tide, and its mean for December was 28°·9.

The sounding of 133 fathoms and no bottom, midway between Capes May and Britannia, is significant of a different ocean along the north coast of Greenland, from the shallow sea north of Asia, North America, and Grinnell Land.

Forty-eight swings, with accompanying time observations, were made with a pendulum furnished by the U. S. Coast and Geodetic Survey. The observations are now in the hands of Assistant Charles S. Pierce for reduction and comparison. I regret that continued mental and physical weakness have prevented more careful and systematic treatment of these subjects. This summary is now presented, as the immediate future promises no better results from my hands.

On the Derivation of a Periodic Variation from a Series of Quantities observed at Equal Intervals of Time.—By Nils Ekholm, Upsala. (*Zeitschrift der österreichischen Gesellschaft für Meteorologie*, Vol. XX. p. 81, 1885.)

In this Paper the author explains and generalises on a method adopted previously by Lamont and Wild for disengaging periodic from non-periodic variations.

The essential feature of the method lies in taking each epoch of the period to be in turn the commencement of the series, and of taking the general mean of the curves thus deduced as the most probable form of the true periodic curve.

By considering all the terms corresponding to the successive epochs as ordinates placed at equal distances, if there were no variations besides the true periodic one, the lines joining the ends of all corresponding ordinates should obviously be parallel to the axis of x. Since as a rule non-periodic variations coexist, this is seldom the case, and the application of the Lamont-Wild method is simply a repeated turning round of the lines joining corresponding ordinates until they become parallel to the axis.

If no account is taken of the actual amount of the corrections to be applied, or, in other words, if the turning is effected about any point and the periodic variation deduced without strict reference to the individual means, the calculation of the mean value of n phases from a period embracing $m+2$ periods is effected by taking the means of all corresponding terms, giving those from the second period to the last but one a weight equal to n, and the terms of the first and last periods respectively weights equal to—

$$1, 2, 3 \quad \ldots \quad \ldots \quad \ldots \quad n-1, n.$$
$$n, n-1 \quad \ldots \quad \ldots \quad \ldots \quad 3, 2, 1.$$

This evidently follows from the fact that whilst every term of the intermediate periods will be used n times, those of the first and last periods will be used exactly as many times as is expressed by their position in the period. The errors due to the partiality of the beginning and end of the series will be thus avoided. The writer suggested this correction some years ago when examining a certain diurnal curve. On comparing the result given by this method with that derived by taking the ordinary arithmetic means, the superiority of it is evident, especially in the reduction of the difference between the values for

midnight and 1 a.m., when the series is calculated from midnight to midnight, or between those for midday and 1 p.m., when the series is calculated from midday to midday; differences which evidently result from the fact that the series may have commenced at the bottom of a cyclone and terminated at the top of an anticyclone, or *vice versâ*. The figures in the example given by the author are those which give the daily variation of air pressure calculated from hourly observations at the Swedish Polar Station at Cape Thordsen, in Spitzbergen (78° 28·5′ N lat., 15° 43′ E long.).

Thus for the epochs just alluded to we have the following results as variations from the mean :—

	A	B	C
	in.	in.	in.
Midnight ...	+0·06	+0·62	
1 a.m. ...	—0·21	—0·03	
Midday ...	+0·18		+0·97
1 p.m. ...	+0·31		—0·45

Where A is the series calculated by the method described, B is the ordinary arithmetic mean series from midnight to midnight, and C from midday to midday.

When account is taken not only of the periodic variation, but also of the values of the individual means, the method of correction becomes a good deal more complicated, as instead of effecting the rotation of the lines joining the ends of the ordinates about any point, the lines joining each pair have to be rotated round their middle points. The author then works this out for the general case of $m + 2$ periods of n terms, and shows that the additional corrections which have to be made to the figures calculated by the plan already discussed are so small, that when the number of observations is not very small they can be altogether neglected. As the case of the diurnal period is the most frequent one, the table of corrections to be added to the terms derived by the first method is given below:—

	0	1 a.m.	2	3	4	Mid-day	1 p.m.	2	3	4	Midnight.
		a_1	a_2	a_3	a_4	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}	a_{24}
1 a.m.	Δ_1	—12	+11	+10	+ 9	+ 1	± 0	— 1	— 2	— 3	—11
2 a.m.	Δ_2	—11	—12	+11	+10	+ 2	+ 1	± 0	— 1	— 2	—10
3 a.m.	Δ_3	—10	—11	—12	+11	+ 3	+ 2	+ 1	± 0	— 1	— 9
4 a.m.*	Δ_4	— 9	—10	—11	—12	+ 4	+ 3	+ 2	+ 1	± 0	— 8
Mid-day	Δ_{12}	— 1	— 2	— 3	— 4	—12	+11	+10	+ 9	+ 8	± 0
1 p.m.	Δ_{13}	± 0	— 1	— 2	— 3	—11	—12	+11	+10	+ 9	+ 1
2 p.m.	Δ_{14}	+ 1	± 0	— 1	— 2	—10	—11	—12	+11	+10	+ 2
3 p.m.	Δ_{15}	+ 2	+ 1	± 0	— 1	— 9	—10	—11	—12	+11	+ 3
Midnight	Δ_{24}	+11	+10	+ 9	+ 8	± 0	— 1	— 2	— 3	— 4	—12

* The figs. for the hours not given can be supplied by symmetry.

Here Δ_1 Δ_2 etc. denote the differences between the corresponding individual terms in the first and last of the successive periods.

If the number of periods, or in this case of days, is $m+2$, the sum of the vertical lines under each hour divided by 24 $(24 (m + 1) + 1)$ gives the required correction.

By an example, the author shows that though in general this correction is small, it brings the result nearer the truth than it could be without it, and that this must especially be the case where the number of periods $m + 2$ is small.

E. DOUGLAS ARCHIBALD.

A NEW METHOD OF READING THE DIRECTION OF THE WIND ON EXPOSED HEIGHTS AND FROM A DISTANCE.

MR. Hugo Leupold, who was unable to be present at the Meeting on November 19th, 1884, when his Paper on the above subject was read,[1] sends the following reply to the remarks made in the discussion :—

[1] *Quarterly Journal*, Vol. XI. p. 1.

"The remarks of Professor Archibald and Mr. Whipple, that they believed they had seen a somewhat similar instrument before, are certainly rather unsatisfactory and vague.

"Regarding the complexity of the code, an objection raised by Mr. Whipple, the author has not found the same to offer any difficulty in practice, the respective figures being easily remembered: besides, this objection, if any, seems to be more than outweighed by the following advantages claimed by the author for his triangle system, namely:—1. A large object or figure for observation is obtained with the smallest amount of surface exposed to the wind, which might disturb the sensitiveness of the vane. The triangles have sides 3 ft. long: the usual letters, N, S, E, W, which would also have to be about 3 ft. to give the same range of observation, were found impracticable, as they projecting on the ends of rods caught the wind, and interfered with the easy working of the vane. 2. Facility of reading from a considerable distance. 3. The surfaces of the triangles exposed to the wind are always comparatively in good balance on each side of the vertical centre, thus not influencing the working of the vane. 4. The facility with which a slight change in the direction of the wind is noticeable, by the alteration in the figure. 5. There being no gearing driven by the vane; and lastly (6) all parts working on one centre.

"Mr. Munro's suggestion of a skeleton dial with the necessary 3 ft. letters and mitre wheels, standing high enough above the ground to avoid an occasional 8-10 ft. of snow, would, the author thinks, make the same a rather formidable instrument."

RECENT PUBLICATIONS.

American Meteorological Journal. A Monthly Review of Meteorology, and allied Branches of Study. Vol. I., Nos. 10-12, February-April 1885. 8vo.

The original articles are:—Determination of Air Temperature and Humidity, by H. A. Hazen (7 pp.).—The South Carolina Tornadoes in February 1883 and 1884, by Dr. W. W. Anderson (10 pp.).—Meteorological Stations in the Atlantic, by F. S. Coburn (1 p.).—Simultaneous Observations of Atmospheric Electricity, by A. McAdie (3 pp.).—The thermal belts and cold island of South-eastern Michigan, by S. Alexander (4 pp.).—The Thunder-squall of July 5th, 1884, in Kentucky, by H. H. Clayton (3 pp.).—The deflective effect of the Earth's rotation, by W. M. Davis (9 pp.).—The Khamsin and other Desert Winds (3 pp.).—A lately discovered Meteorological Cycle, by H. H. Clayton (7 pp.).

Annales du Bureau central Météorologique de France. Publiées par E. Mascart, Directeur. Année 1881, Part II.; Année 1882, Parts I. III. and IV. 4to. 1883-1884.

1881, Part II. contains the detailed observations and monthly results from the French and Algerian stations. The system now includes 89 stations in France, and 33 stations in Algiers. M. A. Angot contributes a most interesting and valuable monthly climatological report for France and the adjacent countries (60 pp.) which is illustrated by 39 beautifully executed charts.—1882, Part I. contains:—Résumé des orages en France et de l'état de l'atmosphère pendant l'année 1881, par E. Fron (14 pp. and 22 plates).—Etude sur la marche des phénomènes de la végétation en France pendant les années 1880 et 1881 (64 pp. and 16 plates).—Sur quelques propriétés fondamentales des surfaces d'égale pression, par L. Teisserenc de Bort (8 pp.).—Part III. (319 pp.) is devoted to the Rainfall for 1882, and contains the daily, monthly and yearly fall at 1,582 stations.—Part IV. contains: Observations sur la température de la mer faites

pendant le cours de la mission de Laponie, par G. Pouchet (24 pp.).—Observations météorologiques faites dans les postes consulaires françaises, résumées par L. Teisserenc de Bort (99 pp.).—The paper comprises the observations made at Trebizonde, Samsoun, La Canée, Tripoli, Rabat, the Canary Islands, the Isthmus of Suez, and the Isthmus of Panama, chiefly during the three years 1880-1882.—Sur une pluie terreuse tombée aux îles Canaries le 22 février 1883, par L. Teisserenc de Bort (10 pp. and 19 plates).

ANNUAIRE DE LA SOCIÉTÉ MÉTÉOROLOGIQUE DE FRANCE. Vol. XXXII. Juin-Juillet 1884. 4to.

Contains :—Sur la marche des phénomènes de végétation en France pendant les années 1880 et 1881, par A. Angot (8 pp.).—La prévision du temps par une méthode graphique, par C. Hauvel (5 pp.)—Sur l'état de la végétation à Liège, le 21 mars 1884, par G. Dewalque (1 p.)—Les crues de la Saône et de ses principaux affluents en 1882, par M. Remise (5 pp.).—Date annuelle du commencement des vendanges au domaine de Rotalier (Jura) 1824-1883, par E. Renou (1 p.).—Sur l'annonce des crues de l'Ohio, par F. Mohan et G. Lemoine (11 pp.).

ANNUAL AND SEASONAL CLIMATIC MAPS OF THE UNITED STATES. By CHARLES DENISON, A.M., M.D. 1885.

The Annual Map graphically illustrates cloudiness in shades of colour, giving percentages ; it has also isothermal lines for every change of 5°, and precipitation lines for each change of 5 ins. of rainfall. The map has special arrows for the prevailing rain-bearing and pleasant weather winds for each section of the country, and tables at the foot of the map giving the comparative windiness and other climatic data for 136 Signal Service stations. The four Seasonal charts in one map graphically illustrate the combined Humidity statistics for the seasons, *i.e.* relative and absolute humidity and cloudiness ; the moist part of the country is shown in four shades of blue, and the dry part in four shades of red, the line between the red and blue being the average of the climate of the United States for the year. There are also the seasonal isothermal lines, the above kinds of weather winds, all the mineral springs and health stations in the United States, and in the tables all the important seasonal averages of statistics. The Map is printed as a wall map, 58 ins. by 41 ins., the four seasonal charts being on one side and the annual climatic map on the other.

AUS DEM ARCHIV DER DEUTSCHEN SEEWARTE. V. Jahrgang 1882. 4to. 1884.

In addition to the Report upon the work of the Seewarte for the year 1882, this contains the following papers :—Bemerkungen über die Meeresströmungen und Temperaturen der Falklandsee, von Dr. O. Krümmel (24 pp. and 2 charts). —Typische Witterungs-Erscheinungen, von Dr. J. van Bebber (45 pp. and 19 plates).—Bericht über die Thermometer Prüfung an der Seewarte (20 pp. and plate).

BEHM'S GEOGRAPHISCHES JAHRBUCH. Vol. X. 8vo. 1885.

Contains :—Bericht über die Fortschritte der geographischen Meteorologie, von Dr. J. Hann (58 pp.). This is the usual biennial report giving an account of all the papers that have been published on Meteorology during the two years 1882 and 1883.

CIEL ET TERRE, REVUE POPULAIRE D'ASTRONOMIE, DE METEOROLOGIE, ET DE PHYSIQUE DU GLOBE. 1er Fevrier—15 Avril 1885. 8vo.

Contains :—La cause principale de la direction plongeante du vent et des calmes tropicaux, par F. Folie (11 pp.).—Le climat du Congo et son influence sur l'homme (16 pp.).—Le simoun et les trombes de sable au Bélouchistan (7 pp. and plate).

INDIAN METEOROLOGICAL MEMOIRS ; being Occasional Discussions and Compilations of Meteorological Data relating to India and the neighbouring countries. Published under the direction of HENRY F. BLANFORD, F.R.S., Meteorological Reporter to the Government of India. Vol. II. Part III. 4to. 1884.

Contains :—Account of the South-west Monsoon Storm of October 8th to 19th,

1882, in the Bay of Bengal, by Prof. John Eliot, M.A. (68 pp. and 3 plates).—This storm originated in the centre of the Bay of Bengal, advanced in a northerly direction across the Ganjam and Orissa coasts, and then recurved, running nearly parallel to the coast in a generally north-easterly direction into Central Bengal, where it finally broke up and disappeared. Among its more remarkable features were the widely diffused and heavy rainfall which accompanied it, the smallness of the barometric depression, and the apparent absence of any well-defined centre.

LONGMAN'S MAGAZINE. No. XXXI. May 1885. 8vo.

This contains a paper on "the Upper Air," by Robert H. Scott, F.R.S. (9 pp.), in which he points out the imperfection of our knowledge of the upper air, and the difficulties with which the study of its conditions is beset.

METEOROLOGISCHE ZEITSCHRIFT. Herausgegeben von der Deutschen Meteorologischen Gesellschaft. Redigirt von Dr. W. KÖPPEN. Zweiter Jahrgang 1885. Hefte 1-4. January-April. 4to.

Contains:—Ueber atmosphärische und Gewitter-Elektricität, von Dr. E. Hoppe (23 pp.). This paper on the relation between the different manifestations of electricity in the atmosphere is mainly historical, and gives the opinions of the earlier investigators.—Zur Charakteristik der Regen in N.W. Europa und Nordamerika, von Dr. W. Köppen (14 pp.). This is an investigation on the basis of the author's proposal for the insertion of data as to the frequency and duration of rainfall in meteorological tables, which was discussed by the Royal Meteorological Society in April 1881.[1] The systems which furnish this information are the Norwegian, and to a certain extent that of the United States.—Zur Geschichte des Nordlichts, von S. Tromholt (3 pp.).—Mikroskopische Beobachtung der Wolken-Elemente auf dem Brocken, von Dr. R. Assmann (6 pp.). The author spent some days in November 1884 at the Brocken station, and used his microscope to test the constitution of the ultimate particles of fog and cloud. He could not find any evidence of the presence of vesicles, so that his observations confirm the views of modern physicists as to the incorrectness of the notion of bubble steam. No indication of solid nuclei, as supposed by Mr. Aitken, could be discovered on the evaporation of fog deposits. Dr. Assmann on a subsequent occasion watched the formation of glazed frost. The water particles were at a temperature of 14° F., and when they settled on objects they at once solidified without the formation of crystals. The successive particles set themselves on in lines to windward; to leeward the arrangement was irregular.—Bericht über einige vorläufige Experimente mit an Drachen befestigten Anemometern, von Prof. E. D. Archibald (5 pp.).—Ueber die Divergenz des durch einen Wassertropfen gespiegelten und gebrochenen Lichtes, von F. Roth (10 pp.).—Ueber den Einfluss der barometrischen Minima und Maxima auf das Wetter in Swinemünde, 1876-1883, von Dr. Krankenhagen (19 pp.).—Das Gewitter vom 1 Februar 1884 in Tours, von M. de Tastes (4 pp.).—Ueber den gegenwärtigen Stand der Kugelblitz-Frage, von Dr. L. Weber (8 pp.).—Die Wind-verhältnisse des Atlantischen Oceans (12 pp. and 2 plates).—Die trockenen Nebel, Dämmerungen und vulkanischen Ausbrüche des Jahres 1783, von Dr. F. Traumüller (3 pp.). (See Note at the end of the Notice of the *Zeitschrift der österreichischen Gesellschaft für Meteorologie*, p. 137.)

PHYSIOGRAPHY. By JOHN EVANS, D.C.L., LL.D., F.R.S. Being one of the Series of Lectures delivered at the Institution of Civil Engineers, Session 1884-85. 8vo. 24 pp. and plate.

This is the first of a course of six Lectures on the Theory and Practice of Hydro-Mechanics, delivered at the Institution of Civil Engineers. Dr. Evans deals with the question of water supply, and shows:—1. That the higher the level and the nearer the sea, especially on our western coasts, the greater is the rainfall; 2. That in these high districts the rocks are, as a rule, more impermeable than in the low, and the supplies to the streams larger and more immediate; 3. That in the low lying and eastern districts the rainfall is small, and the rocks for the most part absorbent; 4. That while providing means for

[1] *Quarterly Journal*, Vol. VII. p. 194.

receiving and dealing with the maximum amount of supply, reliance can only be placed on the minimum and not on the average; 5. That though in the case of permeable soils the absolute minimum of percolation may be disregarded, yet that the average of three years seems to show that not more than 4 or 5 ins. of the annual rainfall can safely be regarded as available for the supply of both the wells and rivers of the district; and 6. That any water abstracted from wells in a permeable district is so much abstracted from the sources of the neighbouring streams, though in many cases it can be and is returned to them after use.

Principles of Forecasting by means of Weather Charts. By the Hon. Ralph Abercromby, F.R.Met.Soc. Issued by the Authority of the Meteorological Council. Official, No. 60. 8vo. 1885. 128 pp. and plate.

This work was undertaken at the request of the Council of the Meteorological Office. The author has made no attempt to treat any branch of the subject in detail, his object has rather been to submit a sketch of the whole, giving principles only, and endeavouring to explain the methods of preparing weather forecasts and issuing storm warnings. The work, which is illustrated by sixty-four blocks, is arranged under the following heads:—1. Synoptic Charts; 2. Gradients and Wind; 3. Isobars and Weather; 4. Weather Sequence; 5. Weather Forecasting; and 6. Storm Warnings. The Appendix contains a reprint of a paper, "Provisional Instructions in making Observations of the Upper Clouds," which have been drawn up for the Office by the Rev. W. C. Ley.

Proceedings of the American Philosophical Society. Vol. XXI. No. 116. 1884. 8vo.

This contains the "Thermometrical Observations at Quito, Equador, taken by Mr. C. B. Brockway, from September 17th, 1858, to June 18th, 1859." The observations were made four times daily, viz. at 9 a.m., noon, 3 p.m., and 9 p.m.: the elevation being 9,492 feet above sea-level. The author calls attention to the equability of the temperature, and that the heavy earthquakes do not materially affect it.

Resultate der wichtigsten pflanzen-phänologischen Beobachtungen in Europa. Von Dr. H. Hoffmann, Professor der Botanik in Giessen. 1885. 8vo. 29 pp. and Plate.

In the introduction the author sets forth the importance of phenological observations, particularly with regard to comparative climatology and biology, and investigates the degree of accuracy to be obtained by this kind of observation. A table is given of fifty-three plants, and of such phases of the same which the author from his long experience thinks most suitable for international adoption. These are arranged according to the calendar, in order to facilitate the observations, so that the observer is directed at once to look at the next phases. This system the author considers preferable to an alphabetical or other arrangement with regard to accuracy. The book contains an alphabetical list of about 2,000 phenological stations throughout Europe, with the geographical situation and elevation above sea-level. Under each station are given in an alphabetical arrangement the mean dates of the single phases known from the place, with the number of years of observation. Only one or two years' observations have been published for a great number of the stations, but others extend over thirty years. These dates are for comparing single places with all the others. The mean dates are given as complete as possible, as such comparisons are the chief object which the author has in view in publishing this work. With regard to spring flowers, Dr. Hoffmann has followed out this plan of comparisons, giving under each station an indication of the number of days the single species open their flowers sooner or later than at Giessen, where he resides, from which place generally speaking the most complete observations have been published. In a "spring map" of Europe at the end of the book the results of these investigations are entered, from which the mean progress of spring through different countries is seen at a glance. In a supplement, Dr. E. Ihne discusses the observations made in Norway, Sweden, and Finland.

SITZUNGSBERICHTE DER KAISERLICHEN AKADEMIE DER WISSENSCHAFTEN. (Vienna.) Bande XC., Abth. II. Nov-Heft. 1884. 8vo.

Contains :—Die Temperaturverhältnisse der österreichischen Alpenländer, von Dr. J. Hann (99 pp.).

SOCIETA METEOROLOGICA ITALIANA. BOLLETTINO MENSUALE PUBBLICATO PER CURA DELL' OSSERVATORIO CENTRALE DEL REAL COLLEGIO CARLO-ALBERTO IN MONCALIERI. Serie II. Vol. IV. Nos. 4-10. March-October 1884. 4to.

The principal papers are :—Onde Atmosferiche prodotte dalla eruzione del Krakatoa in Agosto 1883, del Prof. D. Ragona (2 pp.).—Nuova formola barometrica e tavole per le sue applicazioni, del Prof. G. A. Boltshauser (4 pp.).—Nuovo Anemometroscopio, del Prof. Filopanti (1 p.).

SYMONS'S MONTHLY METEOROLOGICAL MAGAZINE. Vol. XX. Nos. 229-231. February-April 1885. 8vo.

The principal articles are :—Distribution of Rain in Jamaica during the decade 1871-80, by Prof. V. Raulin (2 pp. and plate).—Popular Prognostics (2 pp.).—Denton's Unchangeable Thermometers (1 p.).—The Climate of Assab (3 pp.).—Distribution of Rain in Mauritius during the decade 1871-80, by Prof. V. Raulin (2 pp. and plate).—A floating Mid-Atlantic Meteorological Observatory (3 pp.).—The Climate of Bayonne (2 pp.).

TRANSACTIONS OF THE HERTFORDSHIRE NATURAL HISTORY SOCIETY AND FIELD CLUB. Vol. III. Parts 3 and 4. December 1884 and February 1885. 8vo.

Contains :—Meteorological Observations taken at Throcking, Herts, during the year 1883, by the Rev. C. W. Harvey (9 pp.).—Report on the Rainfall in Hertfordshire in 1883, by the Rev. C. W. Harvey (7 pp.).—On Meteorology and some connected subjects, by G. J. Symons, F.R.S. (5 pp.).

ZEITSCHRIFT DER ÖSTERREICHISCHEN GESELLSCHAFT FÜR METEOROLOGIE. Redigirt von Dr. J. HANN. XX Band. February-April 1885. 4to.

Contains :—Ueber Richtung und Geschwindigkeit der Winde, von Prof. A. Miller-Hauenfels (10 pp.).—W. v. Bezold : Ueber zündende Blitze im Königreiche Baiern während des Zeitraumes 1833-1882 (7 pp.).—Der Nebelglühapparat, von J. Kiessling (5 pp.).—Ueber die Bestimmung der Temperatur und Feuchtigkeit der Luft, von Prof. H. A. Hazen (4 pp.).—Die Regenverhältnisse des malayischen Archipels, von Dr. A. Woeikoff (26 pp.). This is an elaborate discussion of the Reports on the Rainfall of the Malay Archipelago which have been published by the Dutch Government. The author, who himself has visited many of the stations, points out how in several districts the land suffers from want of water, especially in Eastern Sumatra, whereas the general idea of the region of the Dutch East Indies is that it is among the rainiest of the world. He shows how the clearing of the forest for coffee and cinchona plantations has already produced a material difference in the condition of the country in respect of rainfall since Junghuhu wrote his work on Java, more than thirty years ago.—

The April No. contains an Account of a Special Meeting of the Austrian Meteorological Society held in March, at which it was resolved to fuse the *Zeitschrift* with that of the German Meteorological Society. The change will take place in January 1886, and the new journal will be published in Berlin.

Quarterly Journal

OF THE

ROYAL METEOROLOGICAL SOCIETY.

EDITED BY A

COMMITTEE OF THE COUNCIL.

JULY 1885.

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CONTENTS.

Royal Meteorological Society.

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SESSION 1885-86.

DATES OF MEETINGS.

November	18	March	17
December	16	April	21
January*	20	May	19
February	17	June	16

* Annual General Meeting.

The Chair will be taken at 7 p.m.

By permission of the Council of the Institution of Civil Engineers, the above Meetings will be held at 25 Great George Street, Westminster, S.W.

QUARTERLY JOURNAL

OF THE

ROYAL METEOROLOGICAL SOCIETY.

Vol. XI.	JULY 1885.	No. 55.

ADDRESS DELIVERED AT THE ANNUAL GENERAL MEETING, JANUARY 21ST, 1885. BY ROBERT H. SCOTT, M.A., F.R.S., PRESIDENT. (Plate IV.)

FOR the space of twenty-three years none of my predecessors in this chair have dealt with the subject of the actual *status* of meteorology, and it may therefore be of some interest if I attempt to give the Fellows, to the best of my humble ability, a rough conspectus of the present condition of the science in the different countries of the globe, and of the lines of inquiry which appear at the present epoch to be attracting most attention.

There is no lack of literature, for besides occasional papers, many of high value, appearing in the annals and year-books of the several central offices, we have the Journals of the five sister Societies, the French, Scottish, Austrian, Italian and German, naming them in order of age; and at least six Journals, of repute, more or less exclusively devoted to Meteorology. Among these the first rank is undoubtedly taken by the stately *Repertorium* of the Russian office, and the *Indian Meteorological Memoirs*. Then follow the *Monthly Meteorological Magazine*, now in the sixteenth year of its vigorous existence, and the more recent ventures in a similar line; *Ciel et Terre* of Brussels, *Das Wetter* issued by Dr. Assmann, of Magdeburg, and the very newest, the *American Meteorological Journal*. The two last of these periodicals only date from 1884.

With all this wealth of literature there is one particular in which, in this country at least, our science labours under a great disadvantage. So far as I am aware, no instruction is given in it, and no lectures on the subject form part of the course of study at any school or college, except at the strictly profes-

sional institution, the Royal Naval College at Greenwich. In Germany, in the current winter half-year, no less than eleven courses of lectures on Meteorology or Climatology are announced at as many Universities or High Schools. I must not be understood to imply that our university system would admit of such an innovation as to introduce regular lectures on Meteorology, but I think that the Society must, as a body, feel regret that the important professional classes of Medical Men and Civil Engineers, to both of which a correct knowledge of Meteorology is of indisputable moment, should be left to pick up that knowledge, at haphazard, from the few text-books which exist on the subject.

As regards our actual knowledge of the climate of the globe, the *Handbuch der Klimatologie* of our Honorary Member, Dr. Julius Hann, is a perfect treasure-house of information, and the only point to be regretted is that no English publisher will undertake its reproduction in our language.

The map which I have placed on the wall (Plate IV.) will suffice to exhibit the degree to which the earth is covered with observing stations, and consequently the degree of reliance to be placed, in a general way, on statements of climatal results.

The stations represented on the map are not all existing at the present date, and publishing records regularly. I have included all that I could find for which data exist for at least twelve consecutive months at any period during the last quarter of a century, and data sufficiently copious to entitle the station to rank as one of the second order.[1] To this has been added a rough representation of the amount of information existing in the Meteorological Office for the various parts of the sea. I have not endeavoured by shading to represent the various grades of completeness of these data, for the task would have been impossible of fulfilment, the total number of days of observations per ten-degree square ranging from 2 or 3 in the Antarctic regions to upwards of 20,000 in Square III. in the Atlantic. I have therefore only given three shades, representing respectively per ten-degree square—

10,000 and upwards,
5,000 to 10,000,
1,000 to 5,000.

I have not regarded any square containing less than 1,000 days' observations, inasmuch as that would only give about 80 days for each month, a quantity far too small to yield satisfactory results.

Inspection of the map will show where the land stations are most thickly planted, in fact in many parts of Europe and of Upper Canada they lie so close together that it is impossible to show them, and the scale of the map is such that some latitude, and longitude too, must be allowed in the identification of individual stations.

[1] In the Appendix to this Address (p. 153) I have given a list of all the Stations which may be recognised as Stations of the Second Order over the whole globe, with the authorities on which the names in most of the lists have been inserted. There are many more stations in the list than are shown in the Map.

The broad lesson we learn from the map is that, as regards Europe, Greece and Turkey are the only countries badly represented. In Asia, there is practically nothing between Siberia in the north and Hindostan in the south. In Africa, Algeria and the Cape Colony are nearly all that we have any precise knowledge of. North America, as far as it is settled, is amply provided with stations; but in South America the only districts which make a fair show are the Argentine Confederation and Chili. We have some hopes that Brazil may ere long put in an appearance on such a map, but hitherto that vast empire has been nearly as much a *terra incognita* meteorologically, as the Pacific Ocean is, and is likely to remain, almost a *mare incognitum.*

I now come to the subject of the lines of inquiry which are attracting most attention at the present day. In this connection we possess a most valuable standard from which to take our start, in the exhaustive Reports on Meteorology by the late Prof. James D. Forbes, which appeared in the *Reports* for the 2nd and 10th meetings of the British Association for 1832 and 1840 respectively. In the latter of these Reports, which is by far the more complete, the author states his aim to be—

"*First.* To sketch the broad features of the science as it stands.

"*Secondly.* To give the bibliography of the subject within a definite period of years; and

"*Thirdly.* To point out the more conspicuous deficiencies of our knowledge, and the *kind* of observation, experiment, or reasoning by which these blanks may be supplied."

It is of the third of these heads that I now propose to treat.

The Report concludes with lists of the observations to be taken, and the subjects of inquiry to be pursued, according to the opportunities available at three different classes of stations—

1. Public Observatories.
2. Sedentary Observations (corresponding to our Stations of the second order, &c.).
3. Travellers' Observations.

Firstly, as to *Public Observatories,* I may say that no such thing exists in these Islands as a public observatory, of which the persistence is absolutely secured. There is not one which is endowed, so as to be independent of annual subsidies from Government or from other sources. This condition has been secured for the Kew Observatory, *quoad* Magnetism, by the munificence of the late Mr. Gassiot, the proceeds of whose bequest are enjoyed by the Kew Committee, but solely for so long as the continuous registration of magnetic phenomena, and the publication of results deduced therefrom, is maintained.

Of public meteorological observatories maintained by Government or by other bodies we have a sufficient supply, and in one department of their activity, on which Prof. Forbes lays decided stress, we can congratulate ourselves on progress. He says: "Access, under due regulation, should be

permitted to instrument makers and observers to have their instruments compared with the standards."

Shortly after the date of this Report Mr. Glaisher commenced instrumental testing at Greenwich, and in the year 1858, May 30th, the Kew Committee announced that they would receive instruments for verification. This branch of their operations has grown to such an extent that the Kew Report for last year has the following account to give.

"The total number of instruments tested in the past year was as follows:—

Barometers, Standard ...	44
" Marine and Station ...	80
Aneroids ...	84
Total	208
Thermometers, ordinary Meteorological ...	1225
" Standard ...	88
" Mountain ...	164
" Clinical ...	8726
" Solar Radiation ...	42
Total	10240
Hydrometers ...	1161
Anemometers ...	2
Rain-Gauges ...	8
Sextants ...	64
Index and Horizon Glasses, unmounted ...	87
Dark-Glasses, unmounted ...	254

"Besides these, thirteen Deep-sea thermometers have been tested, four of which were subjected, in the hydraulic press, without injury, to pressures exceeding two tons on the square inch. One hundred and forty-two thermometers have been compared at the freezing point of mercury, making a total of 10895 for the year."[1]

The actual observations proposed for public observatories are as follows:—

"1. Thermometer, barometer and moistened bulb hygrometer *at least* every second hour.

"2. Wind may be registered by Whewell and Osler's gauges.

"3. The state of the sky may be frequently noted.

"4. Rain by Osler's gauge; other rain gauges at three vertical stations.

"5. Temperature of the Earth from the surface down to twenty-four French feet. The shorter thermometers must be observed at different hours of the day; the longest once a week.

"6. Temperature of the Earth at a considerable depth in caverns, wells

[1] *Proceedings of the Royal Society*, Vol. XXXVII. p. 468.

or artesian bores. The thermometers (generally) should have their zero verified from time to time (twice a year).

"7. Solar radiation by the actinometer. Nocturnal radiation.

"8. Atmospheric electricity and the aurora borealis, with corresponding magnetic observations.

"9. Falling stars, especially in August and November. Other occasional phenomena of course will be recorded.

"10. Experiments by means of balloons, on the decrement of temperature above the soil."

Of these requirements Nos. 1 and 2 are fully met by the numerous forms of meteorographs, photographic or mechanical, which are now in use.

No. 8 is, however, a department of Meteorology which is practically neglected at large observatories. It is incompatible with the duties of a calculator that he should be constantly out of doors watching the sky, and yet observations on the clouds at regular and infrequent intervals will not throw much light on the constant changes which the sky covering exhibits. The Fellows may remember that when, on a recent occasion, Mr. Ley lectured on clouds, he stated that he had then spent one-twelfth part of his waking existence in watching the sky. There are not many assistants at observatories who could say as much.

Under 4 we may say that the question of the Vertical Distribution of Rainfall has received an apparent solution by the investigations of Mr. Dines and Mr. Symons.

The next two subjects are those to which Prof. Forbes himself paid special attention, but, excepting at Greenwich, the Earth Temperature does not receive much notice at our large observatories. The problem of the distribution of temperature in the interior of the earth has recently had fresh light thrown on it by the results obtained during the piercing of the Mont Cenis and St. Gothard Tunnels, and very lately from the remarkable data derived from the Comstock Lode, Nevada.

The pursuance of this subject, however, would lead us into geological speculations.

In the department of Radiation much remains to be done. We are apparently as far from a satisfactory actinometer now as we were forty years ago. The black-bulb thermometer *in vacuo* is certainly cheap and manageable, but no one who has ever used it is content with the results it yields.

Atmospheric Electricity is studied but at a few stations, and those who have had most experience with the different forms of apparatus will be the first to admit that it is still in the experimental, not in the observational, stage of investigation.

The Aurora is frequently observed, but the concomitant magnetic phenomena are not now recorded at many meteorological observatories. Meteors are now considered to form part of astronomical inquiry.

Lastly, the prospect of the regular use of balloons for observation is as yet nearly as distant as it was in 1840.

Under *Sedentary Observations*, Prof. Forbes classifies all those which are

taken by private observers, corresponding to the Society's stations; and here he particularly urges on observers that they should not confine themselves to the mere multiplication of simple registers, but should take up special series of observations such as those in the following category.

"1. The temperature of the soil at small depths. If the difficulty of procuring long thermometers be an objection, water bottles may be lowered to different depths *in separate tubes of wood* sunk in a well, which is then filled up with earth or sand, and the temperature may be noted by a common thermometer on pulling them up, the openings of the tubes being well stuffed with hay or wool.

"2. Temperature of mines, galleries, deep wells, overflowing or artesian wells, rivers at various distances from their source and from glaciers, the sea and lakes at different depths and seasons.

"3. Modifications of temperature, + or −, *immediately* above the surface of the soil at different hours and seasons.

"4. Decrement of temperature at different heights, and the modification of the annual and diurnal curves due to elevation.

"5. A comparison of the different instruments for measuring solar radiation—Leslie's, Cumming's, Herschel's, Pouillet's.

"6. Observations on nocturnal radiation in different states of the atmosphere, and towards different regions of the heavens (at the same angular elevation); comparison of the ethrioscope (especially the effect of metallic reflectors in increasing cold, questioned by Pouillet); Pouillet's actinometer; the thermo-multiplier.

"7. The ascertainment, by barometric measurement, of the elevation of a number of marked points in the neighbourhood of the observer's residence. A combination of such local results would give the general configuration of a country. The levelling (by the barometer) of the course of rivers and a few of the most elevated points of the intervening mountain chains is most useful.

"8. The relation of the boiling points of fluids, especially water and alcohol, to the barometer, and the supposed anomalies mentioned by Hugi.

"9. The curious anomalies in barometric measurements depending on the difference of temperature of the two stations (Lenz and Galle), and perhaps on the direction of the wind. This is an important, and, in a favourable situation, not a difficult inquiry.

"10. Further comparisons of the dew-point and moist-bulb hygrometer are not necessary. But careful observations with the latter are highly desirable under all possible circumstances. The curves of annual and daily dryness ought to be investigated, and the indications of the instrument reduced, *not by the computation of the corresponding dew-point*, but by ascertaining (from Apjohn's formula) the *absolute* and *relative* dryness of the air, *i.e.* the tension of vapour and the ratio to saturation. Experiments would still be desirable to ascertain the effect of a current of air in modifying the indications of the moistened thermometer.

"11. To pursue experiments on rain-gauges at three stations vertically above one another, combined with hygrometric observations.

"12. To deduce from phenomena proofs of the *revolving* or *radiating* character of storms, or of the existence of both kinds.

"13. To multiply observations upon meteors, especially in August and November. For this purpose nothing more is requisite than the combination of several intelligent observers, who should select particular portions of the heavens for observation, having acquired, by the aid of a globe or planisphere, a sufficient knowledge of the constellations, and who, being each provided with chronometers, should note (1) the time of appearance; (2) the duration of the meteor; (3) its magnitude and physical peculiarities; (4) its direction and velocity of motion.

"14. From what has been said on the subject of atmospheric electricity, it will appear that almost every thing remains to be done on that subject; he who proposes to enter on the field must be prepared to cope with the difficulties of *original* investigation.

"15. Auroral phenomena. The division of them into classes (if possible), of which probably the height, nature, and magnetic effects may be very different.

"16. Many of the departments of optical meteorology are well fitted for sedentary observation."

The first two heads have already come under our notice. In 3 and 4 Prof. Forbes treats of questions which are as yet far from being settled. Under 4, where he speaks of the modification of the annual and diurnal curves, we find, on reference to the text of his Report, that the inversion of temperature distribution, which occurs with anticyclones, was a phenomenon unknown in 1840.

The suggestions on Radiation, both Solar and Terrestrial, are distinctly in relation to experimental investigations, in contrast to regular observations, and a number of instruments now almost obsolete are specified.

Coming to the next three heads, dealing with the barometer, we find the widest difference we have yet experienced between the anticipations of 1840 and the realisations of 1884. In the warm recommendation of extensive barometrical surveying we see no hints of a suspicion that the formula for barometrical reduction to the sea-level rested on a basis at all insecure, and yet the Fellows will remember that my predecessor in this chair threw grave doubts on the admissibility of the whole proceeding.

The idea of Hugi that the boiling point of water anticipated the indications of the barometer, while that of alcohol coincided therewith, has of course naturally turned out to be absurd.

The investigations of Lenz and Galle on anomalies in barometrical measurements had reference to the determinations of the relative altitudes of distant stations by means of the barometer, which naturally was found to vary with the season. This is now intelligible enough when we know the variations in mean pressure at the different seasons, and the relation of the barometer to the wind; but it is very remarkable to find that Prof. Galle, who attended to this latter relation distinctly, abandons all idea of connecting the barometrical differences with the direction of the wind, and attributes them

entirely to its temperature. It was not until the year 1858 that Prof. Adolph Erman (in *Poggendorff's Annalen*, Vol. LXXXVIII.) gave the first statement of what is now known as Buys Ballot's Law. He was led to this discovery in his attempts to correct the formulæ for barometrical levelling.

Under No. 10, I must only remark that the problem of a thoroughly satisfactory mode of effecting hygrometrical determinations is as yet unsolved. The suggestion put out by Prof. Forbes, of ascertaining the effect of a current of air in modifying the readings of a moistened thermometer, has not received as much attention in these Islands as it certainly deserves.

In No. 12 we have a sign of the interest which was excited in 1840 by the great struggle between Redfield and Espy, the champions of the circular and the centripetal theory of storm motion respectively.

Under the head of *Travellers' Observations*, we have, in the first instance, Prof. Forbes' favourite subject, Earth Temperature, with the addition of observations on hot springs, which are certainly not legitimate meteorology. The rest of the suggestions are obvious ones for travellers at all times; but the catalogue bears unmistakeable marks of theories and investigations which attracted more attention in the first half of the century than they do at present.

"1. The temperature of the superficial soil between the tropics, which, as already stated, is generally constant at 1 foot deep, and represents the annual mean. Intimately connected with this is the important general question whether the superficial earth temperature coincides generally with that of the air, which is yet undecided.

"2. The temperature of springs, deep wells, and mines. The elevation of these above the sea should be determined barometrically or otherwise. Where several springs rise near one another, the temperature of several should be recorded. It does not by any means follow that the largest springs *always* give the best results.

"3. Particular attention should be paid to those springs which appear to have a temperature above or below that of the air at the place. In the case of very hot springs it is very interesting to repeat the observation with the same thermometer or instruments which have been compared in different seasons and years.

"4. Meteorological *extremes* have always a certain interest which makes them worthy of preservation, whether they be of atmospheric temperature, solar radiation, pressure, humidity, fall of rain, force of wind, or electric tension.

"5. Daily observations of the barometer are valuable, especially in tropical regions, because there the calculation of heights may at once be completely made without corresponding observations. By these means a traveller's route across a tract of country may be traced in section, and the value of many of his local remarks greatly increased.

"6. Observations continued even for a few days in the equatorial parts of the globe suffice to determine approximately the diurnal fluctuation. The hours seem to be every where nearly the same.

"7. Optical meteorological phenomena of all kinds admit of being peculiarly well studied from the varying points of view in which the traveller is placed. The diameters of rainbows, halos, and coronæ, observed with due accuracy, and the abnormal phenomena which occasionally accompany these appearances, are facts of which as yet we possess but a slender stock. We may specify the following subjects of inquiry:—

(*a.*) The colours of the sky, their optical composition, and connection with the hygrometric state of the air.

(*b.*) The polarisation of the clear sky (observed with Savart's polariscope), the position of the neutral points, its variations, and the cause of the inversion of the plane of polarisation.

(*c.*) The diameter of the rainbow, and the *contemporaneous measures* of the distance of the supernumerary bow from the primary. The *distance* between the primary and secondary rainbow, measured from the brightest part of the red. (This last is an easy and important observation, especially if accompanied with a measure of the distance of the red of the first supernumerary bow from the primary red.)

(*d.*) The diameter (in different direction) of the Great Halos, the condition with respect to polarisation of the parhelic circle, and other rarer appearances.

(*e.*) The phenomenon of *glorified shadows*, in all their particulars, and the state of polarisation of the successive rings. To compare the diameters of the direct coronæ and those by reflection formed in the same cloud.

"8. The decrement of temperature in the atmosphere.

"9. The force of solar and nocturnal radiation at different heights; the effect of atmospheric radiation in the day time in clear and cloudy weather.

"10. The improvement of the theory and practice of barometric measurements.

"11. The dryness of the higher strata of the atmosphere.

"12. The *formation* of clouds, their *structure* and *temperature* (this last point is one of very considerable interest, viz. to compare the temperature of the air within a cloud with that of the comparatively dry surrounding air).

"13. The formation of storms, especially thunderstorms, and the origin of hail. Perhaps no mountains in Europe are so well adapted for these observations as the Middle and Western Pyrenees."

If we consider the subject which has attracted the largest share of attention of late years, it will be generally admitted that it has been the endeavour to gain a knowledge of the condition and movements of the atmosphere at the highest accessible levels.

This has been attempted in three ways: by balloon ascents; by observations of upper clouds; and by establishing mountain observatories.

As to the first of these, it must be admitted that but little has of late years been added to the knowledge gained by the ascents of Welsh and of Glaisher more than twenty years ago. Subsequent ascents have been spas-

modic, and have not been carried out on a plan sufficiently systematic to lead to results of high value.

However, we must always remember that no balloonist in a free ascent can have any exact knowledge of his altitude from time to time, inasmuch as he cannot be aware of the actual rate of diminution of pressure in the vertical direction at the time of his ascent, so that his barometrical readings alone will not tell him his level.

It is also all but impracticable, at a reasonable expense, to repeat an ascent under different conditions of weather. If certain results have been obtained by an ascent in a calm, say at the centre of an anticyclone, it is not feasible to carry out an ascent to a similar height when the conditions are reversed and there is a high wind. Accordingly, any balloon observations are always open to the objection that they represent more or less exceptional conditions, *i.e.* a nearly perfect calm; for the uncertainties of destination and descent are such that no one has yet made a successful ascent for scientific purposes when a strong wind was blowing. We must, therefore, abandon the hope of materially increasing our knowledge by free ascents.

As to captive ascents, it is reasonably easy to repeat these on successive days, and at different hours of the day, but the elevation attainable is never great, and even a moderate wind aloft is sufficient to render an ascent with ordinary holding tackle impracticable. For scientific observations the idea of a moveable base, or cart, to follow the balloon and guide it, such as is used in ballooning for military purposes, is out of the question, for the operations must be carried on in the immediate vicinity of an observatory.

The mode of observation which has been of late practised by one of our Fellows, Mr. Archibald, with considerable success, is available precisely where the balloon fails, for the very wind which sustains the kite renders the management of its rival difficult. The observations, however, which can be conducted by means of kites are limited in extent, for they must be such as can be registered automatically by apparatus of light construction.

The observations of upper clouds, "cirrus," are mainly available for the purposes of weather study, and in this direction they have led to brilliant results in the able hands of the Rev. W. Clement Ley. The great difficulty about them, however, is that they appear to demand a special gift of observing, for it seems nearly hopeless to impart by instruction to the ordinary observer the power of making accurate determinations of the formation and motion of cirrus clouds.

Lastly we come to mountain stations; and these have attracted a large share of public interest, mainly owing to the necessary isolation of and consequent hardships endured by the observers. The absolute height above sea-level of most of the mountain stations is insignificant. Ben Nevis only reaches the height of 4,000, the Puy de Dome of 5,000, and Mount Washington of 6,000 feet, while the highest of all, Pike's Peak, is about 14,000 ft. high, only 2,000 ft. higher than Leh in Ladakh, a city where observations are regularly taken. Many of these stations are not really

peak stations at all. The Great St. Bernard is, as many of the Fellows know well, any thing but a peak; it is a pass with several higher points about it.

A considerable number of such stations have been organised on the Continent of Europe, and the discussion of the records they yield has led Dr. Hann and others to most interesting conclusions as to the diurnal march of the various phenomena at different levels, and more especially as to the changes in the hygrometric condition and the temperature of the air by its passage over mountain chains. We have heard a great deal about Föhn winds of late.

The popular idea of the utility of these stations is, however, that they are mainly of importance as weather reporting points. On this head I have made it my business to inquire of the chiefs of the different meteorological organisations in Europe and the United States, which possess such stations, as to what practical benefit their weather service derives from these reports.

The outcome is scanty in the extreme, and as yet quite incommensurate with the cost and labour of maintaining the stations. General Hazen replies that no telegraphic reports are received from Pike's Peak, but that the information from Mount Washington is of considerable value in weather prediction for the adjacent New England States.

From Europe the replies are less decided. Prof. Mascart says that the reports from the Pic du Midi are of value in giving early warning of floods in the low country, owing to the melting of snow. He also states that the reports from that station and from the Puy de Dome indicate shifts of wind before any signs of their approach are noticeable at the lower level.

Dr. Hann for Austria and Dr. Bilwiller for Switzerland are more cautious, and decline to give positive replies.

On one point all authorities are quite in accord, that the barometrical readings cannot well be used in forecasting. It is quite impossible to reduce the readings to sea-level from such elevations, and the endeavour, among all European meteorologists at least, is to reduce the readings at the upper station to one uniform level at a considerable height above the sea, say 6,000 feet, and so to construct an upper plane of pressure and thus produce two isobaric charts daily, one for the lower, the other for the upper stratum.

The bearing of this on the value, for forecasting purposes, of reports from an isolated station, like Ben Nevis, is sufficiently obvious. It is a very interesting fact to learn that the barometrical oscillations at the summit are particularly sudden and extensive, but no indication has yet been given of any mode of using such observations in forecasting.

We are still likely, in Europe at least, to have to place our dependence mainly on reports from the Atlantic seaboard, and our hope mainly in the education of our reporters in the art of cirrus observation.

The subject of the nature of hurricanes and cyclonic storms still continues to attract as much attention as it did nearly half a century ago. The most important practical additions to our knowledge have resulted from the researches of Dr. Meldrum and of the Indian Meteorological Department for

the Indian Ocean and Bay of Bengal, and of Padre Viñes of the Hàvaña for the West India hurricanes of 1875 and 1876.

The main characteristic of these investigations, as compared with previous studies of the same nature, is that they have for the most part been carried on with the aid of simultaneous observations, so that the amount of material available has been far more copious than that which the earlier investigators had at their disposal.

In addition to the papers I have mentioned, Capt. Schück, of Hamburg, has examined all the cases which he could discover in which one ship was in the central calm, and others at various distances and in various directions from that centre, in order to ascertain if the air really moved in a more or less circular course round that point. His results, as far as they go,—and they represent some thirty different cyclones,—do not show the perfect accordance of fact with theory which is believed to exist, so that positive assertions as to ascertaining the bearing of the centre from the direction of the wind at the ship must be received with caution.

Padre Viñes' paper is a very important document, for the storms discussed have moved along tracks within the area of the Signal Office system, so that the mass of observation available for tracing them has been copious.

The most remarkable outcome of the inquiry is that these storms did not progress like a rotating disc of uniform diameter, but that their violence and their extent waxed and waned, rising to a maximum more than once, and being far less intense in the intervals. Moreover these records throw light on a phenomenon which attracted much notice at the time of the St. Thomas Hurricane of October 1867. The storm began at that island at noon from West-north-west, lulled at 1.30 p.m., and then raged with greater fury from the opposite point, South-east, but only for one hour, in which the main damage was done, as many as eighty ships being lost or seriously damaged at St. Thomas alone. Now a coasting vessel which had left St. Thomas in the morning for one of the adjacent islands escaped the hurricane so completely that its crew did not know one had been felt.

Prof. Eastman, of the U. S. Naval Observatory, in his report on the storm, estimates its diameter at the Island at about thirty-four miles; but it is evident that, for this coaster to have avoided it altogether, serious violence cannot have been exhibited for seventeen miles on all sides of the centre.

Now in all three of the storms the Padre investigated he found that the storms varied much in intensity, the wind force being unequally developed on the two sides of the cyclone, and being always checked by the passage of the storm over land, as over the Island of Cuba, and again increasing when the system reached the open sea beyond. It is probable, therefore, that the fortunate coaster from St. Thomas sailed to the calmer side of the hurricane, under the lee of the island, and possibly during one of the intervals of relaxation of its intensity.

The Padre also directs special attention to the great variations in direction, and extreme gustiness of the wind during the storm.

The whole of the evidence seems to show that the general idea of a perfectly

circular eddy, such as would be represented by Piddington's Storm Cards, requires some modification.

Viñes' work is in Spanish, and it well merits translation into English; and it may be hoped that some of the magazines may possibly reproduce it, at least in abstract, in our language.

Another subject which has attracted much attention on the part of the public has been the endeavour to establish a correspondence between the periodicity of sunspots and the march of meteorological phenomena. The idea of being able to predict the character of individual seasons in this country or elsewhere, which conferred on this theory its great attractiveness, has apparently been abandoned by any but its most enthusiastic votaries, for the rude test of prediction is severe enough for most would-be prophets. The researches at the present time are, in the main, directed to the establishment of periodicity in barometrical and thermometrical waves or surges, extending over immense tracts of the earth's surface, and of course inducing equally extensive modifications of weather. These inquiries involve laborious calculations and the preparation of copious tables, but it is not yet asserted that the recurrence of these surges can be used as a safe basis for prediction. In fact, the very nature of the connection between meteorological and solar phenomena has not yet been authoritatively demonstrated.

Time would fail me if I were to attempt to treat of the modern development of Meteorology, Synoptic Weather Study, but it may be of interest if I say a few words on a grand meteorological undertaking which has been carried out to its full end with brilliant success, though the founder of the scheme was not spared to witness the realisation of his darling projects. I allude to the circumpolar observing stations on the scheme of Carl Weyprecht, of which twelve were in operation in the Arctic and two in the Antarctic regions during the interval from August 1882 to August 1883. Of all these parties one only, the Dutch Expedition to the mouth of the Obi, failed to reach its destination, as described by my predecessor last year; with the exception of one Russian seaman frost bitten on Nova Zembla, the only loss of life was that which occurred with the expedition under Lieut. Greely to Lady Franklin Bay, Smith Sound. The tragic history of this party will be fresh in your memory, and I need not dwell upon it.

At the Meeting in May I had the honour to lay before you a brief notice of the proceedings of the Conference held at Vienna last Easter to decide on the form of publication of the results, and at the same Meeting we were honoured by the presence of Lieut. Ray of the U. S. Signal Office, who had been in charge of the Second U. S. Expedition to Point Barrow.

I am glad to say that by the last information I have received, the discussions, both meteorological and magnetical, are in a very advanced stage, and there is every reason to expect that by the end of the present year this great undertaking will have been brought to a successful issue by the complete publication of its results.

As to actual synoptic work in connection with this scheme, I may announce

that not only will the North Atlantic weather be charted daily for the year by the Meteorological Office, but the South Atlantic will for the first time be similarly treated, by the Deutsche Seewarte, under Dr. Neumayer.

In conclusion, I have only to wish the Society good speed for the year we have just begun. The Balance Sheet which has been placed in your hands shows you that our financial position is satisfactory, and that the action of the Society in increasing its subscription was prudent—to quote the phrase of the Report. Let us hope that with our pecuniary prosperity we shall not grow lazy.

There is, however, one development of luxury in which not only your President and several of the Council, but above all the Staff, are desirous of indulging, that of more commodious apartments for the Society's Offices—if such can be found, *firstly*, at a reasonable distance from this Institution, where we have been so generously entertained for many years, and where we hope to be permitted to remain; *secondly*, at a reasonable rent; and *thirdly*, though last not least, as we all feel years advancing upon us, at a reasonable elevation above the street.

APPENDIX.

The following is a list of the names of the gentlemen to whom I am indebted for lists of the Stations in foreign countries :—

	AUSTRIA-HUNGARY.
Austria	Dr. J. Hann, Vienna.
Hungary	Dr. Guido Schenzl, Buda-Pesth.
Belgium	M. Lancaster, Brussels.
Canada	Mr. Carpmael, Toronto.
Ceylon	Major Clarke, R.A.
Denmark	Dr. Paulsen, Copenhagen.
France	Professor Mascart, Paris.
German Empire	Dr. Hellmann, Berlin. Geheimrath Neumayer, Hamburg.
Bavaria	Dr. von Bezold, Munich.
Saxony	Dr. Schreiber, Chemnitz.
Württemberg	Dr. Meyer, Stuttgart.
Italy	Prof. Tacchini, Rome.
The Netherlands	Prof. Buys-Ballot, Utrecht.
Norway	Prof. Mohn, Christiania.
Portugal	Capt. J. C. de Brito Capello.
Russia	His Excellency Dr. Wild, St. Petersburg.
Finland	Dr. Nordenskiöld, Helsingfors.
Spain	Dr. A. Arcimis, Madrid.
Sweden	Dr. R. Rubenson, Stockholm.
Switzerland	Dr. Billwiller, Zürich.
The United States	General Hazen, Washington.

STATIONS OF THE SECOND ORDER.

EUROPE.

AUSTRIA—HUNGARY.

I.—AUSTRIA.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′	ft.		
Admont	2	47·35	14·28	2040	1853–69, 77–9	Jahrb. d K. K. Cent. Anst. f. Met u. Mag.
Adelsberg	2	45·48	14·18	1814	1849–57,71,2& 9	" "
Aggsbach	2	48·18	15·25	768	1878–84	" "
Althofen	2	46·52	13·58	2310	1849–64	" "
Aussee (Alt)	2	47·39	13·46	3107	1850–84	" "
Aussee (Markt)	2	47·37	13·47	2149	1851–84	" "
Aussig	2	50·40	14·2	502	1877–80	" "
Baden	2	48·1	15·44	775	various.	" "
Banjaluka	2	44·46	17·12	558	1880–84	" "
BARZDORF	1	50·25	17·6	847	1868–84	" "
Biela	2	49·49	18·33	545	1859–68	" "
Bielitz	2	49·49	19·3	1129	1873–84	" "
Bistritz	2	49·24	17·40	1053	1863–84	" "
Bleiberg	2	46·37	13·40	3012	1874–84	" "
Bludenz	2	47·9	9·49	1903	1856–73	" "
Bochnia	2	49·58	20·26	741	1860–63, 76–84	" "
Bodenbach	2	50·46	14·12	459	1848–84	" "
Botzen	2	46·30	11·21	863	1850–84, irreg.	" "
Bregenz	2	47·30	9·45	1345	1869–84	" "
Brixen	2	46·43	11·39	1870	1878–84	" "
Bruck	2	47·24	15·16	1608	1875–84	" "
Brünn	2	49·11	16·36	692	1848–84	" "
Brzezany	2	49·27	24·58	896	1872–80	" "
Bucharest	2	44·26	26·5	288	1858–61	" "
Budua	2	42·22	18·17	39	1874–75	" "
Carlsbad	2	50·13	12·53	1339	1875–84	" "
Cilli	2	46·14	15·16	764	1852–84	" "
Clissa	2	43·33	16·31	1116	1870–78	" "
Coredo	2	46·21	11·5	2723	1878–84	" "
Cornat	2	46·41	12·53	3501	1870–84	" "
Caslau	2	49·57	15·22	919	1852–84	" "
CRACOW	2	50·4	19·57	722	1848–84	" "
Curzola	2	42·59	16·38	30	1855–68	" "
Czernichow	2	49·59	19·41	738	1876–84	" "
CZERNOWITZ	1	48·17	25·56	844	1853–84, irreg.	" "
Datschitz	2	49·5	15·26	1522	1864–84, irreg.	" "
Deutschbrod	2	49·36	15·35	1394	1848–72	" "
Dolnja Tuzla	2	44·32	18·43	892	1879–84	" "
Dornbirn	2	47·24	9·15	1519	1863–70	" "
EGER	1	50·5	12·22	1516	1863–84	" "
Feldkirch	2	47·14	9·36	1493	1875–84	" "
Feldsberg	2	48·45	16·45	787	1876–84	" "
Fleiss	2	47·3	12·55	8990	1870–76	" "
Florian	2	48·13	14·23	965	1864–84	" "
Freistadt	2	48·31	14·30	1883	1877–84	" "
Gastein (Bad)	2	47·7	13·8	3356	1854–84	" "
Georgen, St. im Attergau	2	47·56	13·29	1847	1860–84	" "
Georgen, St. am Langssee	2	46·47	14·26	1936	1876–84	" "
Gleichenberg	2	46·53	15·55	974	1861–65, 78–84	" "
Görz	2	45·57	13·37	308	1870–84	" "
Graz	2	47·4	15·28	1129	1853–84	" "

I. AUSTRIA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N. ° ′	E ° ′	ft.		Jah. d K.K. Cent. Anst. f. Met. u. Mag.
Gresten	2	47·59	14·30	1371	1855–61	
Grussbach	2	48·50	16·24	577	1874–84	,, ,,
Gutenstein	2	47·53	15·52	1529	1873–84	,, ,,
Hallein	2	47·41	13·5	2402	1869–78	,, ,,
Hall	2	47·17	11·30	4882	1876–84	,, ,,
Heiligenblut	2	47·3	12·50	4268	1851–84 irreg.	,, ,,
Horn	2	48·40	15·39	1050	1874–84	,, ,,
Hradisch	2	49·36	17·16	712	1877–84	,, ,,
Hüttenberg	2	46·57	14·33	2569	1866–84	,, ,,
Jaroslaw	2	50·1	22·41	669	1876–84	,, ,,
Iglau	2	49·24	15·36	1752	1873–84	,, ,,
Ischl	2	50·26	15·21	919	1875–77	,, ,,
Innsbrück	2	47·16	11·24	1965	1866–84	,, ,,
Jicin	2	49·46	20·14	1129	1876–84	,, ,,
Jodlownik	2	50·20	15·57	919	1876–84	,, ,,
Josephstadt	2	47·43	13·37	1532	1862–84	,, ,,
Judenburg	2	47·10	14·40	2418	1876–84	,, ,,
Kaaden	2	50·22	13·17	1050	1870–84	,, ,,
Kahlenberg	2	48·17	15·48	1480	1854–58	,, ,,
Kalksburg	2	48·8	16·14	860	1860–84	,, ,,
Kammer	2	47·57	13·37	1555	1879–84	,, ,,
Kirchdorf	2	47·45	14·7	1470	1855–77	,, ,,
KLAGENFURTH	2	46·37	14·18	1437	1848–84	,, ,,
Knappenberg	2	46·57	14·35	3429	1876–84	,, ,,
Knin	2	44·2	16·11	1161	1869–76	,, ,,
Korneuburg	2	48·21	15·50	666	1854–58	,, ,,
Kotzobendz	2	49·46	18·34	1142	1875–84	,, ,,
Krems	2	48·25	15·36	722	1866–84 irreg.	,, ,,
KREMSMÜNSTER	1	48·4	14·8	1260	1848–84	,, ,,
Krumau	2	48·49	14·19	1683	1867–84	,, ,,
Krynica	2	49·24	20·57	1926	1877–84	,, ,,
Kuttenplan	2	49·54	12·43	1706	1877–84	,, ,,
LAIBACH	1	46·3	14·30	942	1850–84	,, ,,
Lambrecht, St.	2	47·4	14·18	3399	1867–84	,, ,,
Landeck	2	47·8	10·34	2490	1872–75	,, ,,
Lardaro	2	45·58	10·40	2438	1867–79	,, ,,
Leipa	2	50·41	14·32	830	1852–84	,, ,,
Leitmeritz	2	50·32	13·59	581	1848–84 irreg.	,, ,,
LEMBERG	1	49·50	24·0	978	1850–84	,, ,,
Leoben	2	47·23	15·8	1785	1878–84	,, ,,
LESINA	1	43·11	16·27	62	1858–84	,, ,,
Liebwerd (Tetschen)	2	50·46	13·42	466	1869–75	,, ,,
Lienz	2	46·50	12·46	2218	1853–80	,, ,,
Liescha	2	46·32	14·53	1772	1879–84	,, ,,
Linz (Freinberg)	2	48·18	14·16	1237	1851–84	,, ,,
Lissa (Lighthouse)	2	43·5	16·14	79	1872–84	,, ,,
LOBOSITZ	2	50·31	14·3	545	1866–84	,, ,,
Lölling	2	46·55	14·6	2772	1858–70	,, ,,
Marburg	2	46·35	15·38	883	1863–66	,, ,,
Maria, St.	2	46·32	9·55	8120	1854–58	,, ,,
Mariabrunn	2	48·12	16·14	722	1871–72, 78–79	,, ,,
Marienberg	2	46·42	10·31	4341	1858–84	,, ,,
Martin, St.	2	46·47	11·14	2057	1861–84	,, ,,
Meran	2	46·40	11·7	1017	1854–77 irreg.	,, ,,
Melk	2	48·14	14·51	820	1855–69 irreg.	,, ,,
Michele, St.	2	46·12	11·8	751	1875–84	,, ,,
Mödling	2	48·5	16·17	787	1875–84	,, ,,
Möllbrücken	2	46·51	13·22	1706	1878–84	,, ,,
Mostar	2	43·20	17·49	167	1879–84	,, ,,

I. AUSTRIA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′	ft.		Jahrb. d K.K. Cent. Anst.
Mürzuschlag	2	47·37	15·41	2218	1852–76 irreg.	f. Met. u. Mag.
Neunkirchen	2	47·43	15·34	1171	1863–69	,, ,,
Neu Sandec	2	49·47	20·42	978	1877–84	,, ,,
Neustadt	2	49·46	17·7	778	1876–84	,, ,,
Neutitschein	2	49·35	18·0	974	1876–84	,, ,,
Obermais	2	46·40	10·44	1119	1870–74	,, ,,
Oberhollabrun	2	48·34	16·4	814	1870–84	,, ,,
Oberleitensdorf	2	50·38	13·36	984	1867–80	,, ,,
OBIRGIPFEL	1	46·30	14·27	6706	1848–84	,, ,,
Ostrawitz	2	49·32	18·23	1408	1872–84	,, ,,
Paierbach	2	47·42	15·20	827	1858–60	,, ,,
Paul, St.	2	46·42	14·52	1293	1848–80	,, ,,
Peter, St.	2	47·2	13·36	3993	1850–78	,, ,,
Pettau	2	46·25	15·52	692	1864–84	,, ,,
Pilsen	2	49·45	13·23	1063	1848–84	,, ,,
PISEK	1	49·19	14·9	1270	1875–84	,, ,,
Plan	2	46·50	10·37	5345	1851–57	,, ,,
Pola	2	49·42	16·16	1745	1875–84	,, ,,
Policka	2	44·52	13·50	105	1864–84	,, ,,
Porer	2	44·45	13·52	23	1872–84	,, ,,
Prägraten	2	47·1	12·22	4252	1856–79, irreg.	,, ,,
Prague	2	50·5	14·25	659	1848–84	,, ,,
PRERAU	1	49·27	17·27	705	1874–84	,, ,,
Prizbram	2	49·38	14·2	1650	1873–84	,, ,,
Punta d' Ostro	2	42·27	18·34	210	1868–84, irreg.	,, ,,
Ragusa	2	42·38	17·37	49	1851–75, irreg.	,, ,,
Raudnitz	2	50·25	13·42	705	1872–75	,, ,,
Reichenau	2	47·42	15·50	1621	1865–84	,, ,,
Reichenberg	2	50·46	15·3	1198	1865–84, irreg.	,, ,,
RIVA	1	45·53	10·50	276	1869–84	,, ,,
Rorregg	2	48·18	15·1	1755	1879–84	,, ,,
Rovereto	2	45·52	10·33	686	1861–69	,, ,,
Rudolfswerth	2	45·48	14·40	515	1865–84	,, ,,
Rustschuk	2	43·49	25·28	115	1866–71	,, ,,
Rzeszow	2	50·3	22·0	787	1853–84	,, ,,
Sachsenburg	2	46·50	13·21	1788	1856–77	,, ,,
Saifnitz	2	46·31	13·32	2592	1853–84	,, ,,
SALZBURG	1	47·48	13·3	1430	1848–84	,, ,,
Sarajewo	2	43·51	18·26	1785	1879–84	,, ,,
SCHAFBERG	1	47·46	13·26	5827	1870–84	,, ,,
Schelletau	2	49·8	15·41	1850	1873–75	,, ,,
Scheibs	2	48·3	14·25	1096	1860–64	,, ,,
Schlaggenwald	2	50·9	12·18	1850	1875–79	,, ,,
Schmittenhöhe	2	47·20	12·44	6348	1879–84	,, ,,
Schneeberg	2	47·46	15·48	4731	1876–78	,, ,,
Schönberg	2	49·58	16·59	1119	1865–84	,, ,,
Senftenberg	2	50·5	15·57	1378	1848–69	,, ,,
Seretto	2	47·57	26·4	1116	1873–79	,, ,,
Sillweg	2	47·13	14·42	2428	1875–77	,, ,,
Stanislau	2	48·55	24·43	715	1849–54, 77–79	,, ,,
Starawies	2	49·43	22·1	948	1873–84	,, ,,
Stryi	2	49·15	23·52	991	1878–84	,, ,,
Stuben	2	47·9	10·9	4610	1872–78	,, ,,
SULINA	1	45·9	29·40	7	1875–84	,, ,,
Tabor	2	49·25	14·40	1453	1873–84	,, ,,
Tarnopol	2	49·36	25·36	997	1861–84	,, ,,
Tarnow	2	50·1	21·0	689	1877–84	,, ,,
Taufers	2	46·55	11·57	2904	1875–84	,, ,,
Taus	2	49·26	12·56	1368	1872–80	,, ,,

I. AUSTRIA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published
		N ° '	E ° '	ft.		Jahrb. d K.K. Cent. Anst. f. Met. u. Mag.
Teschen	2	49·45	18·8	991	1859–73	
Toblach	2	46·44	12·13	4108	1869–84 irreg.	" "
Trent	2	46·6	11·7	846	1856–78 irreg.	" "
TRIESTE	1	45·39	13·46	85	1848–84	" "
Troppau	2	49·56	17·54	912	1876–84	" "
Tüffer	2	46·10	15·12	735	1876–84	" "
Turrach	2	46·58	13·53	4147	1874–84	" "
Unterschäfler Alpe	2	46·29	14·32	3488	1877–84	" "
Vent	2	47·9	10·29	2900	1866–72	" "
VIENNA	1	48·14	16·22	666	1848–84	" "
Wiener Neustadt	2	47·49	16·15	883	1858–76	" "
Vinkovice	2	45·17	18·18	177	1869–71	" "
Wadowice	2	49·53	19·30	879	1876–80	" "
Weisswasser	2	50·30	14·48	997	1865–84	" "
Wielickza	2	49·59	20·5	814	1876–84	" "
Wilten	2	47·16	10·53	1926	1855–70	" "
Windischgarsten	2	47·43	14·20	1978	1877–84	" "
Winterberg	2	49·3	13·46	2349	1848–84 irreg.	" "
Wittingau	2	49·0	14·46	1434	1874–80	" "
Wolfgang, St.	2	47·44	13·27	1814	1875–84	" "
Zara	2	44·7	14·45	72	1854–71 irreg.	" "
Zell am See	2	47·19	12·49	2444	1875–78	" "
Zloczow	2	49·48	24·55	896	1864–84	" "
Znaim	2	48·51	16·3	948	1873–79	" "

II. HUNGARY.

Akna Szlatina	2	47·57	23·52	971	1872–73, 82–84	Jahr. K. Ung. Cent. Anst.
Apatin	2	45·40	18·59	305	1882–84	" "
Arad	2	46·11	21·19	440	1866–76, 79–84	" "*
Árva Váralja	2	49·16	19·21	1644	1849–84	" "*
Baáb	2	48·19	17·52	682	1873–76	" "
Bács-Földvár	2	45·33	20·2	331	1881–84	" "
Baja	2	46·10	18·57	364	1874–84	" "
Bakonybél	2	47·15	17·44	853	1874–84	" "
Balatonfüred	2	46·58	17·54	479	1874–84	" "
Belovár	2	45·55	16·54	459	1872–74, 78–80	" "
Bényus	2	48·50	19·46	1801	1882–84	" "
Besztercze	2	47·7	24·30	1257	1864–84, irreg.	" "*
Beszterczebánya (Neusohl)	2	48·44	19·9	1217	1855–84	" "*
Borostyánkő	2	47·24	16·15	2005	1876–84	" "
Brassó (Kronstadt)	2	45·39	25·31	1818	1848–63, 66–74	" "*
Broód	2	45·9	18·1	328	1869–71, 80–84	" "*
BUDAPEST	1	47·30	19·2	502	1841–48, 61–84	" "
Buziás	2	45·39	21·37	443	1872–75, 83–84	" "
Csáktornya	2	46·23	16·26	558	1871–84	" "
Csík-Somlyó	2	46·21	25·48	2320	1873–84	" "
Debreczen	2	47·31	21·38	453	1853–84	" "*
Déva	2	45·52	22·54	633	1878–84	" "
Dobrócs	2	48·44	19·42	1831	1882–84	" "
Edelény	2	47·9	24·38	420	1858–63	Manuscript 2.
Eger (Erlau)	2	47·54	20·23	568	1850–84	Jahrb. K. ung. C. A. 3.
Eperjes	2	49·0	21·15	856	1860–84	" "*
Eszék	2	45·33	18·42	315	1859–84, irreg.	" "*
Esztergam (Gran.)	2	47·47	18·45	381	1852–60, 70–73	" "*
Felső Lő (Oberschützen)	2	47·18	16·16	1184	1857–70	Publ. K. K. öst. C. A.
Felső Vissó	2	47·43	24·24	1581	1881–84	Jahrb. K. Ung. C. A.
FIUME	1	45·17	14·27	75	1860–62, 68–84	" "*

II. HUNGARY—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
				ft.		
Fogaras	2	45·51	24·58	1430	1882–84	Jahr. K. Ung. C. A.
Földvár (Marienburg)	2	45·49	25·36	1673	1876–84	„ „
Gospić	2	44·33	15·22	1864	1867–69, 73–84	„ „*
Görgény	2	46·46	24·52	1381	1883–84	„ „
Gyula-fejérvár (Carlsburg)	2	46·4	23·35	824	1862, 75–84	„ „*
Hódmező-Vásárhely	2	46·25	20·20	292	1877–84	„ „
Húszth	2	48·10	23·18	551	1881–84	„ „
Ipolyság	2	48·4	18·56	472	1875–84	„ „
Jászberény	2	47·30	19·55	328	1877–84	„ „
Jászfényszarú	2	47·35	19·43	358	1865–66, 69–72	„ „*
Jászó-vár	2	48·41	20·58	896	1882–84	„ „
Kalocsa	2	46·32	18·58	338	1871–84	„ „
Kaposvár	2	46·22	17·48	466	1879–84	„ „
Kassa (Kaschau)	2	48·43	21·16	709	1857–60, 67–84	„ „*
Kecskemét	2	46·54	19·41	440	1873–81, 1884	„ „
Késmárk	2	49·8	20·26	2070	1853–84	„ „*
Keszthely	2	46·46	17·14	384	1871–84	„ „
Kis-Bér	2	47·30	18·5	650	1873–80, 1884	„ „
Kis Czell	2	47·16	17·9	449	1876–84	„ „
Kis Sztapár	2	45·42	19·19	305	1882–84	„ „
Kolosvár (Klausenburg)	2	46·45	23·34	1201	1865–84	„ „*
Komárom (Komorn)	2	47·46	18·9	381	1857–84, irreg.	„ „*
Körmöczbánya (Kremnitz)	2	48·43	18·55	1818	1872–84	„ „
Kőrös (Kreuz)	2	46·1	16·32	515	1866–84, irreg.	„ „*
Kőrös (Nagy)	2	47·2	19·47	377	1876–78	„ „
Körösmező	2	48·16	24·21	2139	1881–84	„ „
Kőszeg (Güns)	2	47·24	16·32	915	1871–84	„ „
Lepoglava	2	46·13	16·3	860	1881–84	„ „
Léva	2	48·13	18·36	509	1866–83	„ „*
Lippa	2	46·6	21·42	433	1881–84	„ „
Liptó Ujvár (Hradek)	2	49·2	19·43	2139	1882–84	„ „
Lokve	2	45·21	14·45	2362	1874–77	„ „
Losoncz	2	48·20	19·40	689	1864–77	„ „*
Lőcse (Leutschau)	2	49·1	20·29	1083	1853–67	Publ. K. K. oest. C. A.
Lugos	2	45·41	21·55	427	1858–65, 77–84	Jahrb. K. ung. C. A.*
Magyar Ó Vár (Ung. Altenburg)	2	47·53	17·16	410	1866–85	„ „*
Mármaros-Szigeth	2	47·56	23·53	886	1876–80	„ „
Maros-Vásárhely	2	46·33	24·35	1122	1878–84	„ „
Medgyes (Mediasch)	2	46·7	24·22	1116	1856–74, 78–84	„ „*
Mehadia (Herculesfürdő)	2	44·54	22·23	525	1854–56, 1884	„ „
Mezőhegyes	2	46·20	20·49	325	1874–84	„ „
Mitrovica	2	44·58	19·37	295	1881–84	„ „
Nagybánya	2	47·38	23·35	745	1875–84	„ „
Nagy Kanizsa	2	46·27	17·0	545	1873–84	„ „
Nagy Mihály	2	48·46	21·56	404	1871–84	„ „
Nagyszeben (Hermannstadt)	2	45·47	24·9	1355	1850–84	„ „*
Nagy Szombat (Tyrnau)	2	48·22	17·35	486	1854–60	Pub. K. K. öst. C. A.
Nagy Várad (Grosswardein)	2	47·3	21·57	446	1871–83	Jahrb. K. ung. C. A.
Nedanócz	2	48·36	18·17	584	1866–84	„ „
Német-Bóly	2	45·58	18·31	443	1881–84	„ „
Nyék	2	47·14	18·40	404	1879–84	„ „
Nyiregyháza	2	47·57	21·43	397	1866–84	„ „*
Nyitra (Neutra)	2	48·19	18·5	564	1857–70, 72–84	„ „*
Ó Gradiska	2	45·9	17·15	335	1853–84, irreg.	„ „*

II. HUNGARY—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′	ft.		
Ó Gyalla	2	47·53	18·12	364	1872–84	Jahrb. K. Ung. C. A.
Óhegy (Altgebirg)	2	48·50	19·7	1595	1882–84	" "
Oravicza	2	45·2	21·44	879	1866–84	" "*
Orsova	2	44·42	22·25	174	1860–61, 71–84	" "*
Páncsova	2	44·52	20·39	259	1859–69, 79–84	" "*
Pannonhalma (Martinsberg)	2	47·33	17·46	928	1856–60, 74–84	" "*
Pápa	2	47·20	17·28	512	1874–79, 1884	" "
Pécs (Fünfkirchen)	2	46·6	18·14	853	1853–58, 71–84	" "*
Pécska	2	46·10	21·4	348	1881–84	" "
Petrozsény	2	45·25	23·23	2044	1876–84	" "
Pohorela	2	48·51	20·2	2264	1873–84, irreg.	" "
Posony (Presburg)	2	48·9	17·6	505	1850–84	" "*
Privigye (Privitz)	2	48·47	18·38	922	1873–84	" "
Rakovácz bei Karlstadt	2	45·29	15·34	377	1872–74, 82–84	" "
Rohoncz (Rechnitz)	2	46·18	16·26	1125	1866–71	" "*
Rozsnyó (Rosenau)	2	48·40	20·33	1066	1855–84, irreg.	" "*
Ruszka bánya (Ruskberg)	2	45·34	22·28	1194	1860–84	" "*
Sárospatak	2	48·19	21·35	404	1872–81	" "
Segesvár (Schässburg)	2	46·13	24·48	1102	1855–84, irreg.	" "*
Selmeczbánya (Schemnitz)	2	48·27	18·54	2024	1848–84	" "*
Sopron (Odenburg)	2	47·41	16·35	538	1856–62, 65–82	" "*
Szász-Régen	2	46·47	24·40	1230	1867–78	" "*
Szathmár	2	47·48	22·53	476	1865, 66, 74–84	" "*
Szeged (Szegedin)	2	46·15	20·9	289	1854–61, 64–84	" "*
Székely-Udvarhely	2	46·18	25·18	1565	1874–84	" "
Székes-fehérvár (Stuhlweissenburg)	2	47·12	18·25	364	1876–78	" "
Sz. Gotthard	2	46·58	16·16	761	1875–76, 78–84	" "
Szepes-Igló	2	48·56	20·35	1526	1873–84	" "
Szinnevér Polyana	2	48·35	23·42	2533	1881–84	" "
Szolnok	2	47·10	20·12	371	1876–84	" "
Szolyva	2	48·27	22·59	676	1874–79	" "
Szombathely (Steinamanger)	2	47·14	16·37	725	1864–84, irreg.	" "*
Szomolnokbánya (Schmölnitz)	2	48·44	20·44	1844	1879–84	" "
Sztavna	2	48·59	22·42	1243	1881–84	" "
Tata (Totis)	2	47·39	18·18	528	1877–84	" "
Temesvár	2	45·46	21·14	338	1873–84	" "
Tokay	2	48·8	21·25	318	1879–84	" "
Topanfalva	2	46·21	23·3	1801	1882–84	" "
Trencsén	2	48·54	18·3	745	1873–84	" "
Uj Tátrafüred	2	49·8	20·12	3294	1880–84	" "
Ujvidék (Neusatz)	2	45·15	19·50	276	1874–84	" "
Ungvár	2	48·36	22·18	463	1872–84	" "
Valeamáre	2	46·0	22·15	538	1882–84	" "
Vásáros Námény	2	48·8	22·19	381	1879–84	" "
Vereczke (Alsó)	2	48·46	23·6	1483	1871–73	" "
Veszprém	2	47·6	17·55	755	1860–64, 1884	" "*
Wallendorf	2	47·9	24·38	1184	1853–63	Publ. K. K. öst. C. A.
ZÁGRÁB (AGRAM)	1	45·49	15·59	535	1857–59, 62–84	Jahrb. K. ung. C. A.*
Zavalje	2	44·45	15·50	1070	1853–61	Publ. K. K. öst. C. A.
Zeng (Senj)	2	45·0	14·54	118	1869–84	Jahrb. K. ung. C. A.*
Zimony (Semlin)	2	44·50	20·24	246	1854–58	Publ. K. K. öst. C. A.
Zsarnócza	2	48·29	18·43	738	1881–84	Jahrb. K. ung. C. A.

NOTE.—The observations of the stations marked with an asterisk for the years preceding 1871 are given in the *Jahrbüchern* and *Uebersichten der Witterung* of the Austrian Central Office.

III. BELGIUM.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′	ft.		
Alost	2	50·56	4·3	33	5	Annales de l'Obs. Roy. de Bruxelles.
Antwerp	2	51·13	4·24	23	8	
Arlon	2	49·40	5·48	1450	12	Mémoires de l'Académie.
Bastogne	2	50·0	5·43	1641	6	" "
Bourg-Léopold	2	51·5	5·15	164	5	" "
BRUSSELS (OBS.)	1	50·51	4·22	187	53	" "
Carlsbourg	2	49·54	5·8	1299	4	" "
Cheroin	2	50·11	5·51	1371	2	" "
Chimay	2	50·3	4·19	787	15	" "
Courtrai	2	50·50	3·16	66	6	" "
Dinant	2	50·16	4·55	315	6	" "
Furnes	2	51·4	2·40	16	11	" "
Gembloux	2	50·34	4·42	505	4	" "
Ghent	2	51·3	3·44	33	48	" "
Hasselt	2	50·56	5·20	131	9	" "
Herenthals	2	51·11	4·50	46	6	" "
Iseghem	2	50·55	3·13	49	5	" "
Jalhay	2	50·37	5·58	951	8	" "
Habay-la-neuve	2	49·42	5·38	1312	1	" "
Herve	2	50·38	5·48	942	1	" "
Lamorteau	2	49·32	5·29	633	8	" "
Lebbeke	2	51·0	4·8	16	8	" "
Lens	2	50·33	3·54	181	3	" "
Les Waleffes	2	50·39	5·13	525	24	" "
Leuze	2	50·36	3·37	148	2	" "
LIÉGE	1	50·38	5·33	213	39	" "
Lierre	2	51·8	4·35	23	4	" "
Louvain	2	50·53	4·42	98	13	" "
Maeseyck	2	51·6	5·48	115	9	" "
Maldeghem	2	51·12	3·28	20	6	" "
Marche	2	50·14	5·21	771	3	" "
Mechlin	2	51·2	4·29	36	9	" "
Mons	2	50·27	3·57	148	8	" "
Namur	2	50·27	4·51	279	22	" "
OSTEND	1	51·14	2·55	59	26	" "
Ostin	2	50·33	4·51	581	2	" "
Philippeville	2	50·12	4·33	951	5	" "
Poperinghe	2	50·51	2·44	56	6	" "
Roux	2	50·27	4·26	381	1	" "
Somerge	2	51·7	3·34	49	8	" "
Stavelot	2	50·24	5·56	919	11	" "
St. Hubert	2	50·2	5·23	144	3	" "
St. Trond	2	50·49	5·11	194	6	" "
Tihange	2	50·32	5·16	279	4	" "
Tirlemont	2	50·48	4·56	154	2	" "
Tournai	2	50·36	3·23	66	3	" "
Turnhout	2	51·19	4·57	82	6	" "
Uccle	2	50·51	4·20	295	5	" "
Verviers (ville)	2	50·36	5·52	541	8	" "
" (tir)	2	50·37	5·53	837	8	" "
Viel Salm	2	50·17	5·55	1148	8	" "
Wasseiges	2	50·38	5·0	443	7	" "
Westmalle	2	51·18	4·41	62	8	" "
Westhinder Lightship	2	51·23	2·28	0	5	" "
Welle	2	50·54	4·3	56	2	" "
Wépion	2	50·24	4·51	591	3	" "
Wielingen Lightship	2	51·24	3·15	0	5	" "

THE BRITISH ISLES.

IV. ENGLAND.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N. ° ′	° ′	ft.		
Aldershot	2	51·14	1·45 W	325	1859–75	Reg. General's Returns.
Allenheads	2	54·48	2·13 W	1360	1856–79	" "
Alnwick	2	55·25	1·42 W	213	1860–64, 80–83	Meteorological Record.
Aspley	2	51·59	0·37 W	460	1858–65	Reg. General's Returns.
Audley End	2	52·1	0·13 E	154	1875–9	Meteorological Record.
Babbacombe	2	50·29	3·31 W	293	1877–84	" "
Banbury	2	52·4	1·21 W	345	1861–65	Reg. General's Returns.
Barnet	2	51·40	0·11 W	212	1881–84	" "
Barnstaple	2	51·5	4·3 W	43	1858–84	" "
Bath	2	51·23	2·21 W	596	1865–71, 77–84	" "
Bedford	2	52·8	0·28 W	112	1854–65	" "
Belvoir Castle	2	52·54	0·45 W	237	1855–66	" "
Bicester	2	51·54	1·9 W		1854–60	" "
Blackheath	2	51·28	0·0	160	1874–84	" "
Bolton	2	53·34	2·26 W	481	1878–84	" "
Boston	2	52·58	0·1 W	20	1867–71	" "
Bournemouth	2	50·43	1·53 W	128	1862–84	" "
Bradford	2	53·48	1·45 W	366	1862–64, 69–84	" "
Brighton	2	50·49	0·8 W	206	1861–65, 71–84	" "
Burghill, Hereford	2	52·5	2·45 W	275	1876–78	Meteorological Record.
Buxton	2	53·14	1·54 W	987	1875–84	" "
Bywell	2	54·47	1·55 W	87	1856–80	Reg. General's Returns.
Calcethorpe	2	53·23	0·7 W	379	1875–76	Meteorological Record.
Cambridge	2	52·13	0·6 E	40	1875–84	Reg. General's Returns.
Cardington	2	52·7	0·25 W	105	1854–84	" "
Carlisle	2	54·54	2·55 W	114	1860–84	" "
Carmarthen	2	51·52	4·18 W	188	1875–84	Meteorological Record.
Caterham	2	51·17	0·6 W	660	1875–79	Reg. General's Returns.
Cheadle, Tean	2	52·58	1·57 W	646	1875–84	Meteorological Record.
Cheltenham	2	51·54	2·3 W	184	1878–84	" "
Chester	2	53·12	2·53 W	65	1878–79	" "
Chigwell Row	2	51·37	0·6 E	186	1874–81	Stations of Second Order.
Churchstoke	2	52·31	3·5 W	540	1876–84	Meteorological Record.
Clifton, Bristol	2	51·27	2·37 W	192	1854–67	Reg. General's Returns.
Cockermouth	2	54·40	3·22 W	146	1862–81	" "
Cramlington	2	53·5	1·37 W	255	1882–84	Meteorological Record.
Croydon	2	51·23	0·4 W	201	1879–84	" "
Derby	2	52·56	1·29 W	174	1854–74	Reg. General's Returns.
Diss	2	52·23	1·7 E	110	1860–66	" "
Douglas	2	54·10	4·29 W	137	1878–81	Stations of Second Order.
Downside	2	51·15	2·29 W	592	1878–83	Meteorological Record.
Durham	2	54·46	1·35 W	336	1873–81	Stations of Second Order.
Eastbourne	2	50·46	0·17 E	12	1867–84	Reg. General's Returns.
Eccles	2	53·28	2·21 W	145	1862–78	" "
Enfield	2	51·40	0·6 W		1854–58	" "
Exeter	2	50·43	3·31 W	140	1854–63	" "
FALMOUTH	1	50·9	5·4 W	165	1869–83	Quarterly Weather Report.
Folkestone	2	51·5	1·10 E	159	1876–80	Stations of Second Order.
Gainford	2	54·33	1·44 W	249	1878–79	Meteorological Record.
Geldeston	2	52·28	1·31 E	37	1880–81	Stations of Second Order.
Gloucester	2	51·52	2·15 W	100	1856–63, 67–80	Reg. General's Returns.
Grantham	2	52·55	0·39 W	179	1854–68	" "
GREENWICH	1	51·29	0·0	155	1840–84	Greenwich Observations.
Guernsey	2	49·27	2·35 W	204	1854–84	Reg. General's Returns.
Halifax	2	53·43	1·52 W	429	1866–84	" "
Hartwell House	2	51·48	0·50 W		1854–65	" "

IV. ENGLAND—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N ° ′	° ′	ft.		
Hastings	2	50·52	0·38 E	172	1875–79	Stations of Second Order.
Hawarden	2	53·11	3·1 W	270	1854–75	Reg. General's Returns.
Hawes	2	54·18	2·11 W	800	1875–77	Meteorological Record.
Helston	2	50·7	5·16 W	106	1854–80	Reg. General's Returns.
Hillington	2	52·48	0·33 E	88	1875–84	Meteorological Record.
Holkham	2	52·52	0·48 E	39	1854–84	Reg. General's Returns.
Hull	2	53·45	0·20 W	14	1867–84	Stations of Second Order.
Jersey (St. Aubin's)	2	49·11	2·10 W	139	1876–81	,, ,,
Kelstern	2	53·24	0·7 W	388	1877–80	Meteorological Record.
Kew	1	51·28	0·19 W	18	1869–83	Quarterly Weather Report.
Kingsley, Frodsham	2	53·18	2·45 W	192	1861–67	Reg. General's Returns.
Lampeter	2	52·7	4·5 W	420	1855–77	,, ,,
Lancaster	2	54·3	2·48 W	114	1881–84	,, ,,
Leaton	2	52·45	2·57 W	266	1878–84	Meteorological Record.
Leeds	2	53·48	1·32 W	137	1854–84	Reg. General's Returns.
Leicester	2	52·39	1·8 W	237	1874–84	Stations of Second Order.
Leyton	2	51·34	0·1 E	93	1861–63	Reg. General's Returns.
Little Bridy	2	50·41	2·34 W	367	1856–64	,, ,,
Liverpool (Bidston)	2	53·24	3·4 W	197	1854–84	,, ,,
Llandudno	2	53·21	3·50 W	88	1861–84	Meteorological Record.
London:						
Battersea	2	51·27	0·10 W	13	1856–69	Reg. General's Returns.
Camden Town	2	51·33	0·8 W	123	1858–84	,, ,,
Dorset Square	2	51·33	0·8 W	146	1868–72	,, ,,
Guildhall	2	51·31	0·6 W	50	1857–73	,, ,,
Regent's Park	2	51·33	0·9 W		1860–64	,, ,,
St. John's Wood	2	51·32	0·12 W	161	1854–64	,, ,,
St. Mary's Hospital (Paddington)	2	51·31	0·11 W		1854–59	,, ,,
St. Thomas's Hospital	2	51·30	0·5 W		1854–60	,, ,,
Whitehall	2	51·30	0·7 W		1856–61	,, ,,
Lowestoft	2	52·29	1·45 E	85	1878–84	Meteorological Record.
Manchester	2	53·29	2·14 W	145	1854–78	Reg. General's Returns.
Mansfield	2	53·8	1·12 W	349	1878–81	Meteorological Record.
Margate	2	51·24	1·24 E	83	1882–84	,, ,,
Marlborough	2	51·25	1·43 W	471	1864–84	,, ,,
North Shields	2	55·0	1·27 W	124	1854–80	Reg. General's Returns.
Norwich	2	52·38	1·17 E	42	1854–80	,, ,,
Norwood	2	51·26	0·6 W	184	1878–84	Meteorological Record.
Nottingham	2	52·57	1·8 W	183	1854–84	Reg. General's Returns.
Osborne	2	50·45	1·15 W	172	1858–84	,, ,,
Oscott	2	52·33	1·51 W	460	1874–81	Stations of Second Order.
Otley	2	53·54	1·42 W	205	1861–71	Reg. General's Returns.
OXFORD	1	51·56	1·16 W	210	1854–84	Radcliffe Observations.
Plymouth	2	50·22	4·9 W	69	1876–84	Reg. General's Returns.
Portsmouth	2	50·48	1·6 W	16	1869–74	,, ,,
Prestwich	2	53·32	2·17 W	294	1877–78	Stations of Second Order.
Princetown, Dartmoor	2	50·33	3·59 W	1360	1875–84, irreg.	Meteorological Record.
Ramsgate	2	51·20	1·25 E	105	1874–81	,, ,,
Rose Hill, Oxford	2	51·56	1·16 W	262	1854–61	Reg. General's Returns.
Royston	2	52·3	0·3 W	269	1854–84	,, ,,
Rugby (Stockton)	2	52·23	1·16 W	289	1878–84	,, ,,
Ryde	2	50·44	1·10 W		1854–57	,, ,,
St. David's	2	51·53	5·16 W	188	1879–81	Stations of Second Order.
St. Leonard's	2	50·51	0·33 E	116	1880–81	,, ,,
Scaleby	2	54·58	2·52 W	111	1879–84	Meteorological Record.
Scarborough	2	54·17	0·23 W	130	1855–63, 79–84	,, ,,
Seaham	2	54·50	1·19 W	58	1873–81	Stations of Second Order.

IV. ENGLAND—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N. ° ′	° ′	ft.		
Sidmouth	2	50·41	3·14 W	30	1866–74	Reg. General's Returns.
Silloth	2	54·52	3·23 W	28	1858–84	" "
Somerleyton, Lowestoft	2	52·29	1·44 E	50	1869–84	" "
Southampton	2	50·55	1·24 W	74	1878–81	Stations of Second Order.
Southborne-on-Sea	2	50·44	1·48 W	90	1879–84	Meteorological Record.
STONYHURST	1	53·51	2·28 W	375	1854–84	Quarterly Weather Report.
Strathfield Turgiss	2	51·20	1·0 W	195	1868–70, 73–84	Meteorological Record.
Streatley, Reading	2	51·27	0·58 W	150	1863–79	Reg. General's Returns.
Taunton	2	51·2	3·7 W	80	1866–75	" "
Teignmouth	2	50·33	3·29 W	60	1854–60	" "
Torquay	2	50·28	3·31 W	150	1854–60, irreg.	" "
Totnes	2	50·26	3·41 W	107	1880–84	" "
Truro	2	50·16	5·3 W	43	1854–84	" "
Uppingham	2	52·35	0·44 W	484	1876–81	Stations of Second Order.
Ventnor	2	50·36	1·10 W	100	1854–65, 77–84	Reg. General's Returns.
Wakefield	2	53·41	1·30 W	96	1854–67, 77–84	Meteorological Record.
West Harptree, Bristol	2	51·18	2·38 W	273	1868–71	Reg. General's Returns.
Weybridge	2	51·22	0·28 W	150	1868–79	" "
Whitchurch, Reading	2	51·27	0·58 W	150	1880–84	" "
Wilton, Salisbury	2	51·4	1·48 W	186	1865–84	" "
Wisbeach	2	52·40	0·7 E	14	1863–77	" "
Wolverhampton	2	52·37	2·8 W	500	1878–84	" "
Worthing	2	50·49	0·22 W	31	1854–74	" "
York	2	53·57	1·5 W	51	1854–73, 77–81	Stations of Second Order.

V. SCOTLAND.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
			W.			
Aberdeen	2	57·9	2·7		1855–84	Journ. Scot. Met. Soc.
ABERDEEN Observatory	1	57·10	2·6	46	1869–84	Quarterly Weather Report.
Aboyne Castle	2	57·5	2·47	453	1879–84	Journ. Scot. Met. Soc.
Airds	2	56·33	5·25	15	1868–84	" "
Annanhill	2	55·37	4·31	165	1871–80	" "
Arbroath	2	56·34	2·35	71	1841–84	" "
Ardnamurchan Lighthouse	2	56·44	6·13	180	1849–84	" "
Auchendrane	2	55·23	4·38	147	1865–74, 82–84	" "
Auskerry Lighthouse	2	59·2	2·34	110	1867–84	" "
Ayr	2	55·30	4·36	30	1855–58	Ordnance Survey.
Balfour Castle	2	56·11	3·5	130	1857–75	Journ. Scot. Met. Soc.
Ballater	2	57·3	3·2	666	1867–71	" "
Balloch Castle	2	56·1	4·35	94	1862–84	" "
Banchory	2	57·7	2·9	99	1858–68	" "
Barra Head Lighthouse	2	56·47	7·39	683	1833–84	" "
Barry	2	56·30	2·45	38	1855–84	" "
Barone Cottage	2	55·50	5·4	116	1876–84	" "
Bell Rock Lighthouse	2	56·26	2·23	93	1814–84	" "
BEN NEVIS Observatory	1	56·48	5·8	4406	1881–84	" "
Benquhat	2	55·22	4·24	1128	1882–84	" "
Bernera	2	58·13	6·53	10	1860–68	" "
Bogside	2	57·11	2·46	894	1869–75	" "
Bowhill	2	55·33	2·55	597	1856–84	" "
Braemar	2	57·0	3·24	1114	1856–84	" "
Bressay Lighthouse	2	60·6	1·8	105	1858–84	" "
" Manse	2	60·10	1·10	25	1856–70	" "
Broomlands	2	55·18	3·37	337	1867–80	" "
Buchan Ness Lighthouse	2	57·28	1·46	130	1827–84	" "

V. SCOTLAND—*Continued.*

Station.[1]	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	W			
		° ′	° ′	ft.		
Butt of Lewis Lighthouse	2	58·31	6·16	170	1862–84	Journ. Scot. Met. Soc.
Cairndow	2	56·15	4·56	25	1865–73	" "
Callton Mor	2	56·8	5·30	135	1856–84	" "
Cally	2	54·52	4·11	140	1871–84	" "
Cantick Head Lighthouse	2	58·47	3·8	115	1858–84	" "
Cape Wrath	2	58·38	5·0	400	1828–84	" "
Carbeth Guthrie	2	55·59	4·21	466	1817–59	" "
Cardross	2	55·58	4·39	100	1863–76	" "
Cargen	2	55·2	3·37	85	1860–84	" "
Carnwath	2	55·42	3·38	695	1869–75	" "
Castle Newe	2	57·12	3·0	868	1856–69	" "
Chanonry Lighthouse	2	57·35	4·5	40	1846–84	" "
Cluny Castle	2	57·12	2·30	280	1871–81	" "
Corran Ferry Lighthouse	2	56·43	5·14	103	1860–84	" "
Corrimony	2	57·20	4·42	545	1863–74	" "
Corsewall	2	55·0	5·9	112	1816–84	" "
Covesea Skerries Lighthouse	2	57·43	3·20	160	1846–84	" "
Cromarty Lighthouse	2	57·41	4·2	60	1846–84	" "
Culloden	2	57·29	4·8	104	1841–80	" "
Cupar, Springfield	2	56·18	3·3	210	1871–84	" "
Dalkeith	2	55·54	3·4	190	1856–84	" "
Dalnaspidal	2	56·50	4·13	1450	1878–84	" "
Deanston	2	56·11	4·4	130	1865–74	" "
Devaar Lighthouse	2	55·26	5·32	120	1854–84	" "
Dhuheartach Lighthouse	2	56·8	6·38	145	1872–84	" "
Dollar	2	56·10	3·40	178	1837–57, 61–84	" "
Douglas Castle	2	55·34	3·50	783	1861–84	" "
Drumlanrig	2	55·16	3·48	191	1856–84	" "
Dumbarton	2	55·57	4·35	27	1882–84	" "
Dumfries	2	55·4	3·36	30	1855–59	" "
" Crichton Obs.	2	55·3	3·35	159	1861–84	" "
Dundee	2	56·28	2·56	164	1865–84	" "
Dunnet Head Lighthouse	2	58·40	3·22	346	1831–84	" "
Dunrobin	2	57·59	3·56	16	1860–84	" "
Dunvegan	2	57·25	6·33	24	1870–84	" "
Eallabus	2	55·45	6·18	71	1866–84	" "
Easdale	2	56·18	5·39	25	1857–63	" "
East Linton	2	55·59	2·39	90	1856–84	" "
East Yell	2	60·33	1·3	176	1858–69	" "
Edinburgh	2	55·56	3·11		1853–84	" "
Elgin	2	57·39	3·19	50	1855–79	" "
Eyemouth	2	55·53	2·6	33	1867–84	" "
Feddinch Mains	2	56·19	2·50	337	1867–74	" "
Fladda Lighthouse	2	56·15	5·41	42	1860–84	" "
Forres	2	57·37	3·37	53	1860–63, 83–84	" "
Fort Augustus	2	57·9	4·38	75	1883–84	" "
Fort William	2	56·49	5·7	30	1875–84	" "
Galashiels	2	55·38	2·51	416	1867–76	" "
Girdle Ness Lighthouse	2	57·9	2·4	185	1833–84	" "
Girvan	2	55·15	4·51	27	1862–74	" "
Glasgow, Belvedere	2	55·0	4·14	54	1881–84	" "
GLASGOW, Observatory	1	55·53	4·18	178	1869–83	Quarterly Weather Report.
Glass Island Lighthouse	2	57·51	6·38	130	1813–84	Journ. Scot. Met. Soc.
Glen	2	55·36	3·7	765	1865–84	" "

V. SCOTLAND—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N ° ′	W ° ′	ft.		
Glenalmond	2	56·27	3·40	529	1876–80	Met. Obs. at Stations of Second Order.
Glencairn	2	55·12	3·54	350	1865–67	Journ. Scot. Met. Soc.
Glendoune	2	55·14	4·51	131	1875–79	" "
Glenlee	2	55·5	4·9	230	1882–84	" "
Gordon Castle	2	57·37	3·5	104	1878–84	" "
Greenock	2	55·56	4·46	233	1856–72, 77–84	" "
Grogarry	2	57·7	7·20	56	1879–84	" "
Haddington	2	55·58	2·45	240	1876–84	" "
Harris					1858–63	" "
Holborn Head Lighthouse	2	58·37	3·32	75	1862–84	" "
Hoy Lighthouse, High	2	58·56	3·17	115	1851–84	" "
" Low	2	58·56	3·17	55	1851–84	" "
Hynish	2	56·27	6·54	50	1841–84	" "
Inchkeith	2	56·2	3·8	220	1813–84	" "
Inveresk	2	55·56	3·2	90	1837–84	" "
Inverness	2	57·29	4·14	17	1866–69, 81–84	" "
Isle of May	2	56·11	2·33	240	1816–83	" "
Kettins	2	56·32	3·14	228	1856–73	" "
Kingussie	2	57·5	4·3	750	1876–82	" "
Kinnaird Head Lighth.	2	57·42	2·0	120	1813–84	" "
Kirkcowan	2	54·55	4·36	200	1873–78	" "
Kirkpatrick Juxta	2	55·18	3·28	338	1856–60	" "
Kirkwall	2	58·58	2·58	40	1862–84	" "
Kyle Akin Lighthouse	2	57·17	5·44	53	1857–84	" "
Lairg	2	58·1	4·22	458	1870–84	" "
Lamlash	2	55·31	5·4	46	1877–84	" "
Laudale	2	56·41	5·41	14	1879–84	Met. Obs. at Stations of Second Order.
Lednathie	2	56·45	3·7	720	1864–84	Journ. Scot. Met. Soc.
Leith	2	55·58	3·9	162	1865–84	" "
Lismore Lighthouse	2	56·27	5·36	103	1833–84	" "
Little Ross Lighthouse	2	54·46	4·5	175	1843–84	" "
Lochindaal Lighthouse	2	55·45	6·22	50	1869–84	" "
Loch Ryan	2	54·59	5·2	46	1847–84	" "
Logie Coldstone	2	57·8	2·56	694	1871–84	" "
Makerston	2	55·35	2·31	213	1841–58	" "
Marchmont	2	55·44	2·25	500	1867–84	" "
McArthur Head Lighthouse	2	55·46	6·3	128	1861–84	" "
Milne Graden	2	55·42	2·12	103	1856–84	" "
Monach Lighthouse	2	57·32	7·42	150	1864–84	" "
Montrose	2	56·42	2·28	14	1857–75	" "
Montrose Ness	2	56·42	2·26	124	1870–84	" "
Mowhaugh	2	55·29	2·17	612	1862–84	" "
Mull of Cantyre Lighthouse	2	55·19	5·48	297	1813–84	" "
Mull of Galloway	2	54·38	4·51	325	1830–84	" "
Mungo'swalls	2	55·46	2·18	270	1857–61	" "
Muthill	2	56·20	3·50	245	1859–71	" "
N. Esk Reservoir	2	55·49	3·21	1150	1861–84	" "
New Pitsligo	2	57·36	2·12	495	1862–84	" "
Nookton	2	56·12	3·0	80	1857–75	" "
North Ronaldshay Lighthouse	2	59·23	2·24	140	1854–84	" "
North Unst Lighthouse	2	60·51	0·53	230	1854–84	" "
Noss Head Lighthouse	2	58·29	3·3	175	1849–84	" "
Oban	2	56·25	5·30	48	1858–65	" "

V. SCOTLAND—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N.	W.			
		° ′	° ′	ft.		
Ochtertyre	2	56·23	3·53	333	1873–84	Journ. Scot. Met. Soc.
Oronsay Island Lighthouse	2	57·9	5·47	58	1857–84	" "
Otter House	2	56·0	5·19	130	1858–67	" "
Paisley	2	55·50	4·27	88	1868–84	" "
Paxton House	2	55·46	2·6	100	1878–84	" "
Pentland Skerries Lighthouse	2	58·41	2·55	170	1813–84	" "
Perth	2	56·24	3·26	66	1855–84	" "
Pinmore	2	55·12	4·49	190	1880–84	" "
Pitlochry	2	56·42	3·44	400	1880–84	" "
Pittenween	2	56·13	2·44	75	1855–63	" "
Pladda	2	55·26	5·7	130	1813–84	" "
Portree	2	57·25	6·11	50	1860–67	" "
Rhinns of Islay	2	55·40	6·31	150	1825–84	" "
Rhu Vaal Lighthouse	2	55·56	6·8	147	1859–84	" "
Ridge Park	2	55·41	3·47	630	1869–84	" "
Rona Lighthouse	2	57·35	5·57	222	1857–84	" "
Rosewell Asylum	2	55·51	3·7	695	1875–84	" "
Roshven	2	56·50	5·46	43	1880–84	" "
Roy Bridge	2	56·55	4·55	310	1882–84	" "
St. Abb's Head	2	55·55	2·8	224	1862–84	" "
St. Andrews	2	56·21	2·47	65	1871–84	" "
St. Kilda	2	57·49	8·38	35	1867–84	" "
Sanda Lighthouse	2	55·17	5·35	165	1850–84	" "
Sandwick	2	59·2	3·18	94	1826–84	" "
Scourie	2	58·21	5·9	45	1857–84	" "
Skeir Vuile Lighthouse	2	55·53	5·50	73	1865–84	" "
Skerryvore Lighthouse	2	56·19	7·7	150	1844–84	" "
Slogarie	2	54·59	4·8	306	1864–70	" "
Sound of Mull Lighthouse	2	56·38	6·4	55	1857–84	" "
South Cairn	2	54·59	5·10	212	1859–74	" "
Start Point Lighthouse	2	59·17	2·22	80	1813–84	" "
Stirling	2	56·6	3·55	233	1857–59	Ordnance Survey.
Stobo Castle	2	55·40	3·20	600	1857–84	Journ. Scot. Met. Soc.
Stoer Head Lighthouse	2	58·14	5·23	195	1870–84	" "
Stornoway Castle	2	58·13	6·23	70	1856–84	" "
" Lighthouse	2	58·11	6·22	56	1853–84	" "
Stronvar	2	56·21	4·23	422	1861–84	" "
Sumburgh Head Lighthouse	2	59·51	1·16	300	1821–84	" "
Sunnyside Asylum	2	56·45	2·29	200	1865–84	" "
Swinton	2	55·43	2·16	200	1870–77	" "
Tarbet Ness Lighthouse	2	57·52	3·47	175	1830–84	" "
Taymouth	2	56·36	3·59	372	1857–65	" "
Thirlstane Castle	2	55·45	2·45	558	1856–80	" "
Thurston	2	55·58	2·28	320	1856–79	" "
Tillypronie	2	57·10	2·57	1120	1871–80	" "
Tongue	2	58·30	4·25	40	1856–74, 78–82	" "
Trinity Gask	2	56·20	3·43	133	1858–76	" "
Turnberry Lighthouse	2	55·20	4·50	96	1873–84	" "
Tyndrum	2	56·26	4·43	792	1859–62	" "
Ushinish Lighthouse	2	57·18	7·12	176	1857–84	" "
Wanlockhead	2	55·24	3·48	1334	1860–84	" "
Whalsey Lighthouse	2	60·25	0·44	145	1854–84	" "
Wolfelee	2	55·22	2·39	601	1872–84	" "
Yester	2	55·54	2·44	429	1856–80	" "

VI. IRELAND.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N ° ′	W ° ′	ft.		
ARMAGH	1	54·21	6·39	202	1869–83	Quarterly Weather Report.
Brookeborough (Colebrooke)	2	54·21	7·22	239	1879–84	Stations of Second Order.
Dublin, City	2	53·20	6·15	51	1873–84	" "
" Phœnix Park	2	53·22	6·21	162	1877–84	Registrar General Ireland.
" Glasnevin	2	53·17	6·16	64	1883–84	Stations of Second Order.
Killarney	2	52·4	9·30	94	1881–84	Meteorological Record.
Londonderry	2	55·0	7·19	93	1879–84	Stations of Second Order.
Markree Castle	2	54·11	8·27	131	1875–84	" "
Parsonstown	2	53·6	7·55	182	1873–84	" "
VALENCIA	1	51·55	10·18	9	1869–84	Quarterly Weather Report.

VII. DENMARK.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
			E			
Anholt	2	56·44	11·39	14	1874–84	Meteorol. Aarbog.
Bogö	2	54·55	12·4	88	1873–84	" "
Copenhagen	2	55·41	12·36	44	1838–84	" "
Fanö	2	55·27	8·24	18	1873–84	" "
Hammershus	2	55·17	14·48	50	1873–84	" "
Herning	2	56·8	8·58	195	1881–84	" "
Marstal	2	54·51	10·33	53	1881–84	" "
Randers	2	56·30	10·0	33	1881–84	" "
Samsö	2	55·50	10·36	66	1873–84	" "
Skagen	2	57·44	10·38	10	1873–84	" "
Söborg	2	56·4	12·16	14	1881–84	" "
VAMDRUP	1	55·25	9·18	131	1874–84	" "
Vestervig	2	56·47	8·20	82	1873–84	" "

VIII. FRANCE.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
Agen	2	44·12	0·37 E	604	1879–84	Ann. du Bureau Cent.
Aix	2	43·32	5·27 E	653	1865–84	Met. de France.
Ajaccio	2	41·55	8·44 E	59	1874–84	" "
Albertville	2	45·40	6·24 E	1116	1866–84	" "
Albi	2	43·56	2·8 E	574	1865–84	" "
Alençon	2	48·26	0·5 E	476	1865–84	" "
Amiens	2	49·54	2·18 E	102	1865–84	" "
Angers	2	47·28	0·34 W	154	1865–84	" "
Apt	2	43·53	5·24 E	748	1875–84	" "
Arras	2	50·18	2·46 E	223	1869–84	" "
Auch	2	43·39	0·35 E	604	1866–84	" "
Aurillac	2	44·56	2·26 E	2192	1865–84	" "
Auxerre	2	47·48	3·34 E	397	1849–84	" "
Avignon	2	43·57	4·48 E	72	1873–84	" "
Ballon-de-Servance	2	47·50	6·48 E	3990	1882–84	" "
Barcelonnette	2	44·23	6·39 E	3652	1869–84	" "
Bar-sur-Seine	2	48·7	4·22 E	518	1865–84	" "
Beauvais	2	49·26	2·5 E	246	1865–84	" "
BecMelen	2	47·39	3·31 W	148	1882–84	" "
Belfort	2	47·38	6·52 E	1240	1879–84	" "
Belle-Isle en-Mer	2	47·21	3·10 W	?	1881–84	" "
Bernay	2	49·6	0·36 E	364	1880–84	" "
Besançon	2	47·14	6·2 E	846	1866–84	" "
Blois	2	47·35	1·20 E	341	1865–84	" "
BORDEAUX	1	44·50	0·35 W	243	1840–84	" "
Bourg	2	46·12	5·13 E	797	1865–84	" "
Bourges	2	47·5	2·24 E	512	1865–84	" "

VIII. FRANCE—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N ° '	° '	ft.		
Brest	2	48·23	4·30 W	210	1810–40; 55–84	Ann. du Bureau Cent. Met. de France.
Caen	2	49·11	0·21 W	69	1865–84	,, ,,
Cap Bear	2	42·32	3·8 E	335	1864–84	,, ,,
Cap Croisette	2	43·13	5·20 E	197	1880–84	,, ,,
Carcassonne	2	43·13	2·21 E	384	1861–84	,, ,,
Carpentras	2	43·57	4·48 E	322	1875–84	,, ,,
Cempuis	2	49·40	1·59 E	554	1880–84	,, ,,
Cette	2	43·24	3·42 E	591	1854–84	,, ,,
Chalons-sur-Marne	2	48·57	4·21 E	295	1865–84	,, ,,
Charleville	2	49·46	4·43 E	476	1865–84	,, ,,
Chartres	2	48·27	1·29 E	525	1862–84	,, ,,
Chateauroux	2	46·49	1·41 E	499	1866–84	,, ,,
Chaumont	2	48·7	5·8 E	1060	1865–84	,, ,,
Clermont Ferrand	2	45·47	3·5 E	1312	1865–84	,, ,,
Cluny	2	46·26	4·39 E	787	1878–84	,, ,,
Commercy	2	48·46	5·34 E	797	1859–84	,, ,,
Dax	2	43·43	1·4 W	52	1865–84	,, ,,
Dijon	2	47·19	5·2 E	797	1873–84	,, ,,
Douai	2	50·22	3·5 E	108	1865–84	,, ,,
Draguignan	2	43·32	6·28 E	584	1865–84	,, ,,
Dunkirk	2	51·3	2·22 E	23	1856–84	,, ,,
Ecorcheboeuf	2	49·51	0·56 E	328	1880–84	,, ,,
Ernée	2	48·18	0·56 W	440	1875–84	,, ,,
Er Hastellic	2	46·54	3·16 W	131	1879–84	,, ,,
Evreux	2	49·2	1·9 E	220	1865–84	,, ,,
Foix	2	42·58	1·36 E	1421	1865–84	,, ,,
Gap	2	44·34	6·5 E	2438	1865–84	,, ,,
Grand Jouan	2	47·34	1·38 W	161	1863–84	,, ,,
Grenoble	2	45·12	5·43 E	715	1866–84	,, ,,
Guéret	2	46·10	1·52 E	1486	1866–84	,, ,,
Hoëdic	2	47·45	2·42 W	?	1879–84	,, ,,
Lagord	2	46·11	1·9 W	79	1866–84	,, ,,
Lamballe	2	48·28	2·31 W	253	1866–84	,, ,,
Laon	2	49·34	3·37 E	577	1865–84	,, ,,
Laval	2	48·4	0·47 W	207	1865–84	,, ,,
Lescar	2	43·20	0·26 W	525	1864–84	,, ,,
Limoges	2	45·50	1·15 E	843	1880–84	,, ,,
Lons-le-Saunier	2	49·40	5·33 E	853	1865–84	,, ,,
Loches	2	47·8	1·0 E	240	1869–84	,, ,,
Lorient	2	47·45	3·22 W	85	1862–84	,, ,,
LYON	1	45·41	4·47 E	981	1851–84	,, ,,
Macon	2	46·18	4·50 E	669	1868–84	,, ,,
Mans, Le	2	48·1	0·12 E	285	1865–84	,, ,,
Marac	2	47·56	5·12 E	1204	1881–84	,, ,,
Marly-le-Roi	2	48·52	2·5 E	410	1880–84	,, ,,
MARSEILLE	1	43·17	5·22 E	246	1766–84	,, ,,
Melun	2	48·33	2·39 E	217	1865–84	,, ,,
Mende	2	44·31	3·30 E	2379	1866–84	,, ,,
Mirecourt	2	48·18	6·8 E	974	1862–84	,, ,,
Montauban	2	44·1	1·21 E	318	1865–84	,, ,,
Montbrison	2	45·36	4·4 E	1306	1866–84	,, ,,
Montpellier	2	43·37	3·53 E	118	1851–84	,, ,,
MONT VENTOUX	1	44·10	5·17 E	6234	1884	,, ,,
Moulins	2	46·34	3·20 E	705	1873–84	,, ,,
Nancy	2	48·42	6·11 E	712	1862–84	,, ,,
NANTES	1	47·13	1·33 W	135	1824–84	,, ,,
NICE (Observatoire)	1	43·42	7·17 E	1116	1883–84	,, ,,
,, (Ecole Normale)	2	43·42	7·17 E	56	1865–84	,, ,,
Nimes	2	43·51	4·21 E	90	1857–84	,, ,,

VIII. FRANCE—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N ° ′	° ′	ft.		
Orleans	2	47·54	1·54 E	358	1865–84	Ann. du Bureau Cent. Met. de France.
Orange	2	44·8	4·48 E	121	1875–84	" "
Paris (Observatoire)	2	48·51	2·29 E	216	1688–84	Annales de l'Observatoire.
PARIS (PARC-ST.-MAUR)	1	48·48	2·29 E	161	1873–84	Ann. du Bureau Cent. Met. de France.
Parthenay	2	46·39	0·15 W	574	1865–84	
Périgueux	2	45·11	0·43 E	292	1865–84	" "
PERPIGNAN (Observatoire)	1	42·42	2·54 E	105	1882–84	" "
" (Ec. Normale)	2	42·42	2·54 E	157	1836–84	" "
PIC-DU-MIDI	1	42·57	0·8 E	9380	1876–84	" "
Poitiers	2	46·35	0·20 E	384	1865–84	" "
Privas	2	44·44	4·36 E	997	1865–84	" "
Puy, Le	2	45·3	3·53 E	2172	1866–84	" "
PUY-DE-DOME (PLAINE)	1	45·46	3·5 E	1273	1873–84	" "
" (SOMMET)	1	45·47	2·57 E	4823	1877–84	" "
Quimper	2	48·0	4·6 W	20	1884	" "
Rennes	2	48·7	1·41 W	105	1867–84	" "
Rochebonne	2	46·12	2·20 W	0	1879–84	" "
Rochefort	2	45·57	0·58 W	26	1840–84	" "
Roche-sur-Yon, La	2	46·40	1·26 W	197	1865–84	" "
Rodez	2	44·21	2·34 E	2051	1845–52, 58–84	" "
Rouen	2	49·26	1·5 E	39	1866–84	" "
St. Honorine-du-Fay	2	49·5	0·30 W	387	1873–84	" "
St. Lo	2	49·7	1·6 W	135	1865–84	" "
ST. MARTIN-DE-HINX	1	43·35	1·16 W	131	1864–84	" "
St. Nazaire	2	47·16	2·12 W	26	1883–84	" "
Sauve, La	2	44·46	0·19 W	331	1865–84	" "
Savenay	2	47·22	1·57 W	138	1872–84	" "
Tarbes	2	43·14	0·5 E	1011	1865–84	" "
TOULOUSE (Observatoire)	1	43·37	1·26 E	636	1839–84	" "
" (Ec. Normale)	2	43·37	1·26 E	486	1865–84	" "
Troyes	2	48·18	4·5 E	351	1865–84	" "
Tulle	2	45·16	1·46 E	814	1865–84	" "
Valence	2	44·56	4·53 E	410	1865–84	" "
Vannes	2	47·40	2·46 W	59	1884	" "
Varzy	2	47·21	3·23 E	758	1865–84	" "
Versailles	2	48·48	2·7 E	423	1846–84	" "
Vesoul	2	47·37	6·9 E	820	1866–84	" "
Villefranche	2	45·59	4·43 E	663	1865–84	" "

THE GERMAN EMPIRE.

IX. PRUSSIA AND GERMANY (IN GENERAL).

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
			E			
Aix la Chapelle	2	50·47	6·5	581	1838–51, 68–84	*Vide* Repertorium der Deutschen Meteorologie von Dr. G. Hellmann, Leipzig, Englemann, 1883.
Altmorschen	2	51·4	9·37	640	1866–84	
Altona	2	53·33	9·56	108	1822–35, 56–84	
Angerburg	2	54·13	21·45	407	1881–84	
Apenrade	2	55·3	9·25	66	1812–84, irreg.	" "
Arnsberg	2	51·23	8·4	663	1817–84, irreg.	" "
Arnstadt	2	50·50	10·57	958	1823–70, 76–84	" "
Arys	2	53·48	21·56	400	1847–51	" "
Berlin	2	52·30	13·24	160	1755–84, irreg.	" "
Bernburg	2	51·48	11·43	295	1863–78	" "
Beuthen	2	50·21	18·55	951	1830, 75–84	" "
Birkenfeld	2	49·39	7·10	1299	1861–84	" "
Bonn	2	50·44	7·6	184	1848–70	" "
Boppard	2	54·14	7·36	328	1846–84	" "
Borkum	2	53·35	6·40	13	1876–84	" "

IX. PRUSSIA AND GERMANY (IN GENERAL)—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			*Vide* Repertorium der Deutschen Meteorologie von Dr. G. Hellmann, Leipzig, Englemann, 1883.
		° ′	° ′	ft.		
Braunsberg	2	54·23	19·50	10	1826–69	
Bremen	2	53·5	8·48	13	1803–76, irreg.	
Breslau	2	51·7	17·2	482	1791–84, irreg.	" "
Brocken	2	51·48	10·37	3747	1821–84, irreg.	" "
Bromberg	2	53·8	18·1	154	1848–84	" "
Brunswick	2	52·16	10·31	230	1824–84, irreg.	" "
Bunzlau	2	51·16	15·33	630	1870–84	" "
Cassel	2	51·19	9·30	561	1842–46, 64–84	" "
Celle	2	52·38	10·6	131	1853–63	" "
Clausthal	2	51·48	10·20	1942	1855–84	" "
Cleves	2	51·48	6·7	180	1849–84	" "
Coburg	2	50·16	10·58	968	1828–32, 45–72	" "
Cologne	2	50·56	6·57	197	1848–84	" "
Crefeld	2	51·20	6·34	131	1847–79	" "
Cuxhaven	2	53·52	8·43		1863, 72–74	" "
Dantzig	2	54·21	18·40	72	1807–80, irreg.	" "
Darmstadt	2	49·52	8·39	486	1830–84	" "
Diedenhofen	2	49·21	6·10	545	1873–82	" "
Ebersdorf	2	50·13	16·41	1391	1877–84	" "
Eichberg	2	50·54	15·48	1142	1859–84	" "
Eisenach	2	50·59	10·20	722	1821–30, 80–84	" "
Elsfleth	2	53·15	8·28	23	1858–67; 70–84	" "
Emden	2	53·22	7·13	33	1836–84	" "
Erfurt	2	50·59	11·2	663	1817–84, irreg.	" "
Eutin	2	54·8	10·37	135	1857–84	" "
Flensburg	2	54·47	9·26	72	1866–84	" "
Frankenheim	2	50·33	10·4	2493	1824–34, 79–84	" "
Frankfort a. M.	2	50·7	8·41	338	1826–84	" "
Frankfort a. O.	2	52·22	14·33	138	1848–84	" "
Fraustadt	2	51·48	16·19	338	1883–84	" "
Friedland i. Mecklenburg	2	53·40	13·33	66	1877–80	" "
Fulda	2	50·34	9·41	902	1804–54, 67–84	" "
Gardelegen	2	52·32	11·24	171	1870–84	" "
Geisenheim	2	50·0	7·52	354	1881–84	" "
Giessen	2	50·35	8·41	466	1844–84	" "
Glatzer Schneeberg	2	50·12	16·50	3970	1883–84	" "
Glückstadt	2	53·47	9·26	33	1866–84	" "
Godesberg	2	50·41	7·9	213	1874–84	" "
Görlitz	2	51·9	14·59	712	1837–84	" "
Gotha	2	50·57	9·43	1007	1828–74, irreg.	" "
Göttingen	2	51·32	9·56	492	1857–84	" "
Gramm	2	55·17	9·3	131	1856–84	" "
Grossbreitenbach	2	50·35	11·1	2067	1866–84	" "
Grünberg i. Schlesien	2	51·56	15·30	492	1878–84	" "
Guhrau	2	51·40	16·33	328	1872–84	" "
Gütersloh	2	51·54	8·23	266	1835–84	" "
Hadersleben	2	55·15	9·29	49	1869–84	" "
Halle a. d. Saale	2	51·29	11·38	364	1819–38, 51–84	" "
HAMBURG	1	53·33	9·58	66	1807–84, irreg.	" "
Hanau	2	50·8	8·55	377	1843–84	" "
Hanover	2	52·22	9·44	203	1822–39, 55–84	" "
Hechingen	2	48·21	8·58	1683	1861–84	" "
Heiligenstadt	2	51·22	10·8	843	1844–84	" "
Hela	2	56·36	18·49	16	1852–84	" "
Hildesheim	2	52·9	9·57	282	1855–63	" "
Hinrichshagen	2	53·28	13·30	338?	1840–76	" "
Höhenzollern	2	48·19	8·58	2822	1861–84	" "
Husum	2	54·28	9·3	16	1866–84	" "
Insterburg	2	54·38	21·48	131	1883–84	" "

IX. PRUSSIA AND GERMANY (IN GENERAL)—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′	ft.		
Jena	2	50·56	11·35	525	1820–84	*Vide* Repertorium der Deutschen Meteorologie von Dr. G. Hellmann, Leipzig, Englemann, 1883.
Jever	2	53·34	7·54	69	1833–42, 57–84	
Kalau	2	51·45	13·57	167	1871–80	„ „
Kappeln	2	54·40	9·56	33	1869–84	„ „
KEITUM	1	54·54	8·22	30	1876–84	„ „
Kiel	2	54·19	10·9	16	1849–84	„ „
Klaussen	2	53·48	22·7	472	1837–47, 52–84	„ „
Königsberg i. Preussen	2	54·43	20·30	75	1827–84	„ „
Köslin	2	54·11	16·11	115	1848–84	„ „
Kolberg	2	54·10	15·36	?	1844–53, 55–61	„ „
Konitz	2	53·42	17·34	515	1849–84	„ „
Kranz	2	54·57	20·29		1852–69	„ „
Kreuznach	2	49·50	7·51	341	1851–70	„ „
Laach	2	50·24	7·15	935	1869–72	„ „
Landeck	2	50·21	16·53	1460	1863–73, 79–84	„ „
Landsberg a. d. Warte	2	52·44	15·14	105	1874–84	„ „
Langensalza	2	51·7	10·39	659	1861–84	„ „
Langenschwalbach	2	50·9	8·4	1066	1876–84	„ „
Lauenburg i. Pommern	2	54·33	17·45	98	1862–84	„ „
Leobschütz	2	50·12	17·49	928	1805–51	„ „
Liegnitz	2	51·13	16·10	394	1836–44	„ „
Lingen	2	52·32	7·19	95	1855–84	„ „
Löningen	2	52·44	7·45	105	1857–84	„ „
Lübeck	2	53·52	10·41	66	1840–84	„ „
Lüneburg	2	53·15	10·24	59	1853–84	„ „
MAGDEBURG	1	52·8	11·38	177	1824–72, 79–84	„ „
Marburg	2	50·49	8·46	787	1817–84, irreg.	„ „
Marggrabowa	2	54·2	22·30	577	1884	„ „
Marnitz	2	53·22	11·56	308	1865–84	„ „
Meiningen	2	50·34	10·25	1020	1845–84, irreg.	„ „
Meldorf	2	54·5	9·5	33	1831–63, 66–84	„ „
MEMEL	1	55·43	21·8	46	1814–26, 48–84	„ „
Mühlhausen i. Thüringen	2	51·12	10·28	682	1833–73	„ „
Münster i. Alsace	2	48·2	7·8	1253	1876–84	„ „
Münster i. Westphalia	2	51·58	7·37	207	1818–84, irreg.	„ „
Neisse	2	50·28	17·20	673	1823–51	„ „
Neubrandenburg	2	53·33	13·15	197	1859–61, 63	„ „
NEUFAHRWASSER	1	54·24	18·40	13	1876–84	„ „
Neumünster	2	54·4	9·59	89	1856–63, 66–84	„ „
Neunkirchen	2	49·20	7·1	745	1851–59	„ „
Neustadt i. Holstein	2	54·6	10·50	56	1856–60, 66–84	„ „
Neustrelitz	2	53·21	13·13	289	1829–84 irreg.	„ „
Norderney	2	53·43	7·8		1858–70	„ „
Nordhausen	2	51·30	10·47	728	1872–84	„ „
Oldenburg	2	53·8	8·13	33	1837–84, irreg.	„ „
Oldesloe	2	53·48	10·22	148	1857–73	„ „
Olsberg	2	51·22	8·30	1056	1864–84	„ „
Oppeln	2	50·40	17·55	532	1837–48, 58–84	„ „
Oslebshausen	2	53·8	8·44	66	1876–84	„ „
Osnabrück	2	52·16	8·3	223	1872–84	„ „
Osterode a. Harz	2	51·44	10·15	725	1855–84	„ „
Ostheim vor der Rhön	2	50·27	10·14	958	1878–81	„ „
Otterndorf	2	53·48	8·54	23	1855–84	„ „
Paderborn	2	51·43	8·45	394	1848–66	„ „
Posen	2	52·25	16·56	269	1848–84	„ „
Potsdam	2	52·23	13·4	115	1877–84	„ „
Proskau	2	50·35	17·52	492	1848–58	„ „
Putbus	2	54·21	13·28	174	1853–84	„ „
Ratibor	2	50·6	18·13	636	1842–84	„ „

IX. PRUSSIA AND GERMANY (IN GENERAL)—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N ° ′	E ° ′	ft.		*Vide* Repertorium der Deutschen Meteorologie von
Regenwalde	2	53·46	15·24	180	1858–84	Dr. G. Hellmann, Leipzig,
Reichenbach (Silesia)	2	50·44	16·38	853	1866–69	Englemann, 1883.
Reinerz	2	50·24	16·24	1739	1823–33, 67–84	” ”
Rostock	2	54·5	12·7	72	1832–84	” ”
Rudolstadt	2	50·44	11·0	712	1877–84	” ”
Rügenwaldermünde	2	54·26	16·23	13	1854–68	” ”
Salzwedel	2	52·51	11·9	85	1848–69, 80–84	” ”
Sangerhausen	2	51·29	11·18	525	1877–84	” ”
Schneekoppe	2	50·44	15·44	5246	1824–84, irreg.	” ”
Schönberg i. Meckl.	2	53·51	10·56	33	1848–84	” ”
Schönberg i. Westpreussen	2	54·13	18·7	833	1850–59	” ”
Schreiberhau	2	50·50	15·31	2083	1875–84	” ”
Schwerin (Mecklenburg)	2	53·37	11·25	161	1849–84	” ”
Segeberg	2	53·56	10·18	141	1866–84	” ”
Sigmaringen	2	48·5	9·13	1864	1835–60, irreg.	” ”
Soest	2	51·35	8·7	348	1882–84	” ”
Sondershausen	2	51·22	10·51	669	1861–84	” ”
Spremberg	2	51·34	14·22	384	1881–84	” ”
Stettin	2	53·26	14·34	131	1836–84	” ”
Stralsund	2	54·18	13·5	46	1827–47, 51–53	” ”
SWINEMÜNDE	1	53·36	14·17	20	1826–35, 76–84	” ”
Thorn	2	53·1	18·37	171	1821–25, 72–84	” ”
Tilsit	2	53·5	21·54	46	1820–84	” ”
Tondern	2	54·56	8·52	23	1870–84	” ”
Torgau	2	51·34	13·0	335	1848–84	” ”
Treves	2	49·46	6·38	479	1849–84	” ”
Wang	2	50·47	15·43	2871	1863–84	” ”
Weimar	2	50·59	11·19	738	1821–30, 68–84	” ”
Wernigerode	2	51·50	10·47	771	1852–74	” ”
Westerland auf Sylt	2	54·54	8·19	16	1857–59, 72–84	” ”
Wiesbaden	2	50·5	8·14	364	1842–46, 69–84	” ”
Wilhelmshaven	2	53·32	8·9	26	1865–84	” ”
WUSTROW	1	54·21	12·25	36	1848–84	” ”
Zechen	2	54·40	16·42	328	1839–71	” ”
Ziegenrück	2	50·37	11·40	951	1848–56	” ”
Heligoland (British)	2	54·11	7·51	121	1873–84	” ”

X. BADEN.

Baden	2	48·46	8·14	669	1869–84	” ”
Badenweiler	2	47·48	7·40	1375	1870–84	” ”
Bretten	2	49·2	8·42	612	1870–84	” ”
Buchen	2	49·31	9·19	1130	1869–84	” ”
Carlsruhe	2	49·1	8·25	408	1779–1884	” ”
Donaueschingen	2	47·57	8·30	2263	1871–84	” ”
Freiburg	2	48·0	7·51	955	1869–84	” ”
Heidelberg	2	49·25	8·42	398	1871–84	” ”
Höchenschwand	2	47·44	8·10	3315	1869–84	” ”
Mannheim	2	49·29	8·27	362	1781–92, 41–84	” ”
Meersburg	2	47·42	9·16	1332	1869–84	” ”
Villingen	2	48·4	8·27	2344	1869–84	” ”
Wertheim	2	49·46	9·31	486	1869–84	” ”

XI. BAVARIA.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N ° ′	E ° ′	ft.		
Ansbach	2	49·18	10·35	1357	1833–59, 79–84	Beobacht. der Met. Stat. im Kön. Bayern.
Aschaffenburg	2	49·59	9·8	450	1833–84	" "
Augsburg	2	48·22	10·54	1638	1812–84	" "
Bayreuth	2	49·57	11·34	1178	1807–43, 51–84	" "
Bamberg	2	49·54	10·53	788	1825–84	" "
Dinkelsbühl	2	49·4	10·19	1471	1881–84	" "
Dürkheim	2	49·28	8·10	439	1863–71, 77–84	" "
Hohenpeissenberg	2	47·48	11·1	3261	1781–1884	" "
KAISERSLAUTERN	1	49·27	7·46	794	1843–45, 70–84	" "
Kissingen	2	50·12	10·5	689	1879–84	" "
Landshut	2	48·32	12·10	1300	1879–84	" "
Markt-Heidenfeld	2	49·51	9·37	517	1881–84	" "
MUNICH	1	48·9	11·34	1734	1825–84	" "
Nuremberg	2	49·27	11·5	1036	1820–84, irreg.	" "
Passau	2	48·34	13·28	1025	1879–84, irreg.	" "
Ratisbon	2	49·1	12·6	1178	1792–1884	" "
Scheyern	2	48·30	11·27	1706	1881–84	" "
Speyer	2	49·19	8·21	343	1879–84	" "
Weissenburg	2	49·2	10·58	1402	1876–84	" "
Würzburg	2	49·48	9·56	588	1871–84	" "

XII. SAXONY.

Annaberg	2	50·35	12·40	1992	1864–84	Up to 1875 in Result. aus den Met. Beob. in Sachsen.
Bautzen	2	51·11	14·5	725	1864–84	From 1882 in Jahrbuch des
Chemnitz	2	50·51	12·35	1073	1864–84	Königl. Sächs. Met. Inst.
Dresden (Forst strasse)	2	51·4	13·24	423	1836–84	(Results for 1876–81 not
Dresden (Polytechnikum)	2	51·4	13·24	390	1876–84	yet published.)
Döbeln	2	51·7	12·47	604	1869–84	" "
Elster	2	50·17	11·54	1591	1864–84	" "
Frankenberg	2	50·55	12·41	984	1881–84	" "
Freiberg	2	50·55	13·0	1335	1829–61, 64–84	" "
Königstein	2	50·55	13·44	1178	1864–84	" "
Leipzig	2	51·20	12·3	390	1825–84	" "
Niederpfannenstiel	2	50·36	12·22	1194	1876–84	" "
Oberwiesenthal	2	50·25	12·38	3041	1858–84	" "
Plauen	2	50·29	11·48	1227	1864–84	" "
Rehefeld	2	50·45	13·21	2261	1864–84	" "
Reitzenhain	2	50·34	12·53	2553	1862–84	" "
Schneeberg Griesbach	2	50·36	12·18	1768	1877–84	" "
Tharand	2	50·59	13·35	725	1868–84	" "
Zittau	2	50·54	14·29	863	1828–55, 64–84	" "
Zwickau	2	50·43	12·9	906	1864–84	" "

XIII. WÜRTTEMBERG.

Amlishagen	2	49·16	9·58	1542	1839–62	Staatsanzeiger für Württ.
Biberach	2	48·6	9·47	1762	1868–84	Württ. Jahrbücher für Sta-
Bissingen	2	48·36	9·32	1230	1839–64	tistik u. Landeskunde.
Bönnigheim	2	49·3	8·16	722	1861–72	" "
Ellwangen	2	48·57	10·8	1903	1859–64	" "
Ennabbeürren	2	48·27	9·39	2559	1846–62	" "
Freudenstadt	2	48·28	8·24	2405	1846–84	" "

XIII. WÜRTTEMBERG—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′	ft.		Staatsanzeiger für Württ.
Friedrichshafen	2	47·39	9·28	1335	1826–84	Württ. Jahrbücher für Statistik u. Landeskunde.
Gräfenhausen	2	48·52	8·34	919	1861–64	
Hausen ob Verena	2	48·3	8·43	2635	1875–84	,, ,,
Heidenheim	2	48·41	10·9	1617	1847–84	,, ,,
Heilbronn	2	49·8	8·43	545	1839–84	,, ,,
Herrenalb	2	48·48	8·26	1214	1874–75	,, ,,
Hohenheim	2	48·43	9·13	1312	1836–84 irreg.	,, ,,
Hohentwiel	2	47·46	8·49	1755	1865–69	,, ,,
Isny	2	47·41	10·2	2366	1832–84	,, ,,
St. Johann	2	48·29	9·19	2493	1880–84	,, ,,
Kalw	2	48·43	8·44	1142	1843–84	,, ,,
Kannstatt	2	48·48	9·13	725	1843–84	,, ,,
Kirchheim ü. T.	2	48·39	9·27	1056	1864–84	,, ,,
Mergentheim	2	49·29	9·46	725	1847–62, 66–84	,, ,,
Mittelstadt	2	48·34	9·14	919	1851–67	,, ,,
Münsingen	2	48·25	9·30	2349	1874–84	,, ,,
Munderkingen	2	48·14	9·38	1673	1874–84	,, ,,
Oberstetten	2	49·23	9·56	1079	1838–66	,, ,,
Ochsenhausen	2	48·5	9·57	2034	1861–64	,, ,,
Oehringen	2	49·12	9·30	787	1836–62, 67–84	,, ,,
Reutlingen	2	48·29	9·13	1263	1853–56	,, ,,
Schopfloch	2	48·32	9·32	2526	1841–84	,, ,,
Spaichingen	2	48·4	8·45	2231	1843–60	,, ,,
Stuttgart	2	48·47	9·10	879	1795–1884, 1795–1825, irreg.	,, ,,
Sulz am Neckar	2	48·22	8·38	1440	1861–83	,, ,,
Tigerfeld	2	48·16	9·23	2405	1872–73	,, ,,
Tübingen	2	48·31	9·3	1066	1819–84, 1819–61, irreg.	,, ,,
Tuttlingen	2	47·59	8·49	2110	1829–52	,, ,,
Ulm	2	48·24	9·59	1568	1845–84	,, ,,
Wildbad	2	48·45	8·33	1414	1863–64	,, ,,
Zeil	2	47·52	9·59	2474	1878–84	,, ,,

XIV. GREECE.

Athens	2	37·58	23·44	334	1859–82	Zeit. für Met. XIX. p. 473.
Corfu	2	39·38	19·33	99	1869–79	,, XIX. p. 223.
Patras	2	38·15	21·37	56	1870–75	,, XIII. p. 251.

XV. ITALY.

Agnone	2	41·48	14·22	2644	1880–84	Annali dell' Uff. Cen. di Met. Ital.
ALESSANDRIA	1	44·54	8·37	321	1857–84	
Ancona	2	43·37	13·31	99	1864–84	,, ,,
AQUILA	1	42·21	11·34	2411	1874–84	,, ,,
AREZZO	1	43·27	11·53	909	1876–84	,, ,,
ASCOLI PICENO	1	42·54	13·35	544	1877–84	,, ,,
Asti	2	44·54	8·12	466	1882–84	,, ,,
Auronzo	2	46·33	12·27	2858	1876–84	,, ,,
AVELLINO	1	40·56	14·45	1215	1881–84	,, ,,
BARI	1	41·9	16·51	92	1866–84	,, ,,
BELLUNO	1	46·8	12·14	1325	1875–84	,, ,,
BENEVENTO	1	41·7	14·48	558	1869–84	,, ,,
BERGAMO	1	45·42	9·41	1254	1871–84	,, ,,

XV. ITALY—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′	ft.		
Biella	2	45·34	8·3	1424	1867–84	Annali dell Uff. Cen. di Met. Ital.
BOLOGNA	1	44·30	11·20	300	1813–84	" "
Bra	2	44·42	7·52	1037	1862–84	" "
BRESCIA	1	45·32	10·13	564	1870–84	" "
Cagliari	2	39·13	9·6	115	1877–84	" "
CALTANISSETTA	1	37·20	14·2	1871	1875–84	" "
Camaldoli	2	43·46	16·30	3681	1883–84	" "
CAMERINO	1	43·8	13·4	2177	1866–84	" "
Casale Monferrato	2	45·7	8·27	397	1870–84	" "
CASERTA	1	41·3	14·22	250	1872–84	" "
Castellaneta	2	40·38	16·56	780	1882–84	" "
CATANIA	1	37·30	15·3	102	1866–84	" "
CATANZARO	1	38·55	16·47	1092	1865–84	" "
CHIETI	1	42·22	14·11	1118	1868–84	" "
Citta di Castello	2	43·27	12·14	970	1879–84	" "
Cogne	2	45·37	7·19	5062	1871–84	" "
COMO	1	45·48	9·7	..	1845–47, 73–84	" "
Conegliano	2	45·53	12·17	279	1881–84	" "
COSENZA	1	39·19	16·17	839	1873–84	" "
CREMONA	1	45·8	10·3	223	1881–84	" "
CUNEO	1	44·23	7·32	1820	1877–84	" "
Desenzano	2	45·28	10·32	344	1884	" "
Domodossola	2	46·7	8·18	965	1872–84	" "
FERRARA	1	44·51	11·37	75	1865–84	" "
FIRENZE	1	43·46	11·15	239	1832–84	" "
FOGGIA	1	41·27	15·31	287	1873–84	" "
FORLI	1	44·13	12·2	164	1865–84	" "
Fossano	2	44·32	7·46	1257	1880–84	" "
Gallipoli	2	40·4	18·1	93	1880–84	" "
GENOVA	1	44·24	8·55	177	1833–84	" "
GIRGENTI	1	37·16	13·23	837	1868–84	" "
Jesi	2	43·30	13·13	387	1867–84	" "
LECCE	1	40·22	18·12	236	1875–84	" "
LIVORNO	1	43·33	10·18	78	1856–84	" "
LUCCA	1	43·51	10·31	102	1877–84	" "
MANTOVA	1	45·10	10·47	131	1840–84	" "
Martano	2	40·12	18·18	351	1883–84	" "
MASSA CARRARA	1	44·2	10·7	254	1881–84	" "
MESSINA	1	38·12	15·33	118	1877–84	" "
MILANO	1	45·28	9·11	483	1764–1884	" "
MODENA	1	44·39	10·56	211	1830–84	" "
MONCALIERI	1	45·0	7·41	848	1866–84	" "
Mondovi	2	44·23	7·48	1824	1867–84	" "
Moncenisio	2	45·14	7·0	6332	1882–84	" "
Monte Cassino	2	41·31	13·48	1730	1876–84	" "
Monte Cave	2	41·45	12·52	3166	1877–84	" "
Monte Vergine	2	40·58	15·12	4518	1884	" "
NAPOLI, S.R.	1	40·52	14·15	489	1821–84	" "
NOVARA	1	45·30	8·35	551	1875–84	" "
Oderzo	2	45·47	12·29	67	1876–84	" "
Oppido Mamertina	2	38·20	16·0	1201	1878–84	" "
PADOVA	1	45·24	11·50	101	1725–1884	" "
Palazzolo Acreide	2	37·4	14·15	2165	1883–84	" "
PALERMO	1	38·7	13·21	237	1806–84	" "
PARMA, O.U.	1	44·48	10·19	295	1821–84	" "
PAVIA	1	45·11	9·9	313	1817–84	" "
Penne	2	42·28	13·57	1368	1876–84	" "
PERUGIA	1	43·7	12·23	1706	1866–84	" "
PESARO	1	43·55	12·53	45	1866–84	" "

XV. ITALY—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′			
Pescia	2	43·54	10·43	266	1868–84	Annali dell' Uff. Cen. di Met. Ital.
PIACENZA	1	45·3	9·40	236	1872–84	„ „
Pico. S. Bernardo	2	45·40	6·56	7087	1878–84	„ „
PISA	1	43·44	10·24	33	1880–84	„ „
Pizzo	2	38·44	16·12	197	1884	„ „
Pordenone	2	45·57	12·39	112	1873–84	„ „
Portici	2	40·48	14·20	269	1884	„ „
PORTO MAURIZIO	1	43·53	8·3	206	1876–84	„ „
POTENZA	1	40·39	15·48	2711	1879–84	„ „
Ravenna	2	44·25	12·14	..	?	„ „
REGGIO CALABRIA	1	38·8	15·39	49	1865–84	„ „
REGGIO EMILIA	1	44·42	10·38	202	1866–84	„ „
Riposto	2	37·41	15·12	45	1875–84	„ „
ROMA, C.R.	1	41·54	12·29	163	1825–84	„ „
ROVIGO	1	45·3	11·47	30	1878–84	„ „
SALERNO	1	40·42	14·45	172	1864–84	„ „
Salò	2	45·36	11·1	302	1878–84	„ „
San Giovanni in Galilea	2	44·0	12·42	1451	1883–84	„ „
San Remo	2	43·50	7·46	30	1865–84	„ „
Sant' Agata Feltria	2	43·51	12·13	1909	1881–84	„ „
SASSARI	1	40·40	9·10	719	1875–84	„ „
Savona	2	44·19	8·28	85	1875–84	„ „
SIENA	1	43·19	11·19	1143	1839–84	„ „
SONDRIO	1	46·10	9·54	1191	1882–84	„ „
Spinea di Mestre	2	45·29	12·41	56	1880–84	„ „
Stelvio	2	46·32	10·25	8343	1875–84	„ „
SIRACUSA	1	37·3	15·15	71	1871–84	„ „
TERAMO	1	42·40	13·43	938	1875–84	„ „
Tiriolo	2	38·55	16·32	2060	1881–84	„ „
TRAPANI	1	38·3	12·32	88	1881–84	„ „
TREVISO	1	45·40	12·13	84	1859–84	„ „
Tropea	2	38·43	15·54	169	1876–84	„ „
TORINO	1	45·4	7·41	903	1866–84	„ „
UDINE	1	46·4	13·13	381	1828–84	„ „
Urbino	2	43·43	12·38	1483	1849–84	„ „
Valdobbia	2	45·47	7·54	8360	1872–84	„ „
Vallombrosa	2	43·43	11·33	3130	1878–84	„ „
Varallo	2	45·49	8·17	1526	1871–84	„ „
Velletri	2	41·41	12·48	1316	1868–84	„ „
VENEZIA	1	45·26	12·20	69	1836–84	„ „
VERONA	1	45·26	11·1	217	1796–1884	„ „
VICENZA	1	45·33	11·32	182	1858–84	„ „
Vigevano	2	45·18	8·52	377	1873–84	„ „
Viterbo	2	42·26	12·7	1172	1874–84	„ „
Volpeglino	2	44·54	8·58	751	1871–84	„ „

XVI. THE NETHERLANDS.

Amsterdam	2	52·22	4·53	14	17	Nederl. Meteorol. Jaarboek.
Assen	2	52·59	6·34	52	18	„ „ „
Flushing	2	51·26	3·35	0	31	„ „ „
GRONINGEN	1	53·13	6·34	49	37	„ „ „
HELDER	1	52·57	4·45	0	40	„ „ „
Hellevoetsluis	2	51·50	4·7	0	26	„ „ „
Leeuwarden	2	53·12	5·47	13	41	„ „ „
Maastricht	2	50·51	5·42	164	33	„ „ „
Tilburg	2	51·33	5·4	33	10	„ „ „
UTRECHT	1	52·5	5·7	43	37	„ „ „

XVII. NORWAY.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′	ft.		
Aalesund	2	62·28	6·10	47	1860–84	Jahrbuch des Norweg. Met. Inst.
Aalhus	2	61·32	6·6	714	"	" "
Aas	2	59·37	10·47	302	"	" "
Alten	2	69·58	23·15	43	"	" "
Bergen	2	60·24	5·20	57	"	" "
Bodö	2	67·17	14·24	26	"	" "
Brönö	2	65·28	12·13	34	"	" "
CHRISTIANIA	1	59·55	10·43	81	"	" "
Christiansand	2	58·8	8·0	49	"	" "
Christiansünd	2	63·7	7·45	51	"	" "
Domsten	2	61·53	5·40	36	"	" "
Dovre	2	62·5	9·7	2110	"	" "
Eidsvold	2	60·22	11·14	615	"	" "
Elverum	2	60·53	11·34	623	"	" "
Fagernes	2	68·27	17·25	25	"	" "
Flesje	2	61·10	6·32	16	"	" "
Florö	2	61·36	5·2	26	"	" "
Fredrikstad	2	59·13	10·56	18	"	" "
Fruholmen	2	71·6	23·59	52	"	" "
Gjæsvär	2	71·6	25·22	21	"	" "
Granhejm	2	61·6	8·58	1295	"	" "
Hammerfest	2	70·40	23·40	44	"	" "
Hole	2	60·4	10·16	336	"	" "
Jüstedal	2	61·33	7·19	515	"	" "
Karasjok	2	69·17	25·35	438	"	" "
Kistrand	2	70·26	25·15	32	"	" "
Krappeto	2	59·9	11·38	356	"	" "
Lœrdalsören	2	61·6	7·22	16	"	" "
Lödingen	2	68·24	16·1	44	"	" "
Mandal	2	58·2	7·27	54	"	" "
Molde	2	62·44	7·11	20	"	" "
Oxö	2	58·4	8·4	37	"	" "
Ranen	2	66·12	13·38	43	"	" "
Reine	2	67·56	13·9	41	"	" "
Rena	2	61·8	11·22	740	"	" "
Röros	2	62·34	11·23	2064	"	" "
Röst	2	67·31	12·9	27	"	" "
Sandösund	2	59·5	10·28	27	"	" "
Skudesnes	2	59·9	5·16	13	"	" "
Sogndal	2	61·18	7·3	99	"	" "
Stenkjär	2	64·1	11·30	27	"	" "
Sydvaranger	3	69·40	30·10	67	"	" "
Tonning	2	61·53	6·42	16	"	" "
Tromsö	2	69·39	18·58	50	"	" "
Trondhjem	2	64·1	10·24	31	"	" "
Tönset	2	62·17	10·45	1616	"	" "
Ullensvang	2	60·20	6·40	99	"	" "
Vadsö	2	70·4	29·47	33	"	" "
Vardö	2	70·22	31·8	33	"	" "
Vœrö	2	67·41	12·37	39	"	" "
Ytteröen	2	63·49	11·14	249	"	" "

XVIII. PORTUGAL.

			W			
Campo Maior	2	39·2	6·59	945	1864–84	Ann. do Observ. do Infante D. Luiz.
COIMBRA	2	40·12	8·30	463	1866–84	Resu. de las Obs. Met. de Provincias.

XVIII. PORTUGAL—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	W			
		° ′	° ′	ft.		Ann. do Observ. do Infante
Faro	2	37·1	7·57	56	Jan. 1885	D. Luiz.
Guarda	2	40·32	7·14	3409	1864–84	" "
LISBON	1	38·43	9·9	313	1856–84	" "
Montalegre	2	41·49	7·45	3183	1881–84	" "
Oporto	2	41·9	8·29	328	1864–84	" "
SIERRA DA ESTRELLA	1	40·25	7·35	4728	1881–84	" "
Villa Fernando	2	38·58	7·15	1230	June 1884	" "
Vizeu	2	40·39	7·57	1621	1881–84	" "

XIX. RUSSIA.

			E			
Aitador	2	44·25	34·8	269	1882–84	Annalen des physikalischen Central-Observatoriums.
Alaghir	2	43·2	44·15	2067	1853–63	
Alexandropol	2	40·48	43·49	4823	1849, 51–70	
Alexandrowsk	2	47·50	35·15	197 ?	1850–55	" "
Alexeewskaja Staniza	2	50·17	42·11	427 ?	1850–58	" "
Alt-Subbath	2	56·12	25·2			" "
Aralych	2	39·53	44·30	2592	1849–53	" "
Archangel	2	64·33	40·32	33	1813–31, 33–84	" "
Ardagan	2	41·8	42·50	5860	1880–84	" "
Arensburg	2	58·15	22·30	0	1843–55	" "
Astrakhan	2	46·21	48·2	−66	1837–42, 45–84	" "
Atkarsk	2	51·52	45·0			" "
Awandus	2	59·3	26·26	394	1857–65	" "
Baku	2	40·22	49·50	0	1848–84	" "
Balachna	2	56·29	43·36	197 ?	1842–45, 47–84	" "
Baluschew-Potschinki	2	54·46	41·34	333	1881–84	" "
Baranowo	2	56·54	39·14			" "
Batoum	2	41·40	41·38	10	1882–84	" "
Bausk	2	56·25	24·11	92 ?	1882–84	" "
Belyj-Kljutsch	2	41·33	44·28	3773	1867–84	" "
Betanija	2	41·41	44·32	3924 ?		" "
Blagodat	2	58·17	59·47	1250 ?	1877–84	" "
Boasta	2	45·47	47·31	−85 ?	1880–84	" "
Bobrov	2	51·6	40·4			" "
Bogoslovsk	2	59·45	60·1	623	1838–84	" "
Borshom	2	41·51	43·24	2608 ?	1877–84	" "
Bransk	2	52·45	22·50			" "
Carlo	2	65·2	24·34	33 ?	1817–36	" "
Chotimsk	2	50·3	35·45			" "
Dagerort (L. H.)	2	58·55	22·12	230	1866–84	" "
Dago-Kertell	2	58·59	22·46	0	1849–57	" "
Dalmatov	2	56·13	63·0	328 ?	1861–72	" "
Derbend	2	42·3	48·18	−16	1849, 51–55	" "
Dnestrowskij-Snak	2	46·5	30·29	0	1863–72	" "
Dome Ness (L. H.)	2	57·46	22·36	0	1859–84	" "
Dorpat	2	58·23	26·43	230	1866–84	" "
Doroschewitschi	2	52·10	28·13	410	1880–84	" "
Dubovka	2	49·3	44·50			" "
Dunamunde (L. H.)	2	57·3	24·1	0	1865–84	" "
Efremow	2	53·8	38·7	614	1882–84	" "
Eisk	2	46·40	38·16	427	1872–84	" "
Ekaterinburg	2	56·49	60·35	886	1836–84	" "
Ekaterinodar	2	45·1	38·58	295	1853–56, 59–61	" "
Ekaterinoslav	2	48·27	35·4	197 ?	1839–55, irreg.	" "

XIX. RUSSIA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′	ft.		
Ekaterinoslav' sche Lehrfahrm	2	47·40	37·35	722?	1849–50, 53–56	Annalen des physikalischen Central-Observatoriums.
Elez	2	52·37	38·30			" "
Enissala	2	44·56	34·38	1509?	1833–72, irreg.	" "
Filsand (L. H.)	2	58·23	21·50	33	1865–84	" "
Genitschesk	2	46·15	34·48	42?	1883–84	" "
Georgievsk	2	44·9	43·29	951	1847–51	" "
Glasow	2	58·8	52·41	394?	1843–71	" "
Gori	2	41·59	44·6		1876–84	" "
Gorki	2	54·17	30·59	689	1841–84, irreg.	" "
Gorodischtsche	2	49·17	31·27	295	1872–84	" "
Grodno	2	53·41	23·50	328?	1839–43	" "
Gudaur	2	42·28	44·28	7087	1870–73	" "
Gulynki	2	54·14	40·0	295	1866–67, 71–84	" "
Gurjew	2	47·7	51·55	−58?	1878–84	" "
Haggers	2	59·9	24·39	197	1869–84	" "
Hanehl	2	58·38	23·35	33	1871–84	" "
Hapsal	2	58·57	23·32	0	1866–84	" "
Hogland (L. H.)	2	60·6	26·59	33	1865–84	" "
Idwen	2	57·55	25·11	197?	1853–67	" "
Irbit	2	57·41	63·2	230	1854–57, 72–84	" "
Ischak	2	55·53	47·0	230?	1852–56	" "
Isjum	2	49·11	37·17			" "
Istobenskoe	2	58·26	48·42			" "
Iwanischtschewskoe	2	55·47	62·30	328?	1857–61	" "
Jaroslav	2	57·38	39·53	262	1839–48	" "
Jegelecht	2	59·27	25·7	131	1843–51	" "
Jelnia	2	54·34	33·11	656?	1845–53	" "
Kadnikov	2	59·30	40·20			" "
Kalisch	2	51·46	18·6			" "
Kallbodgrund (L. H.)	2	59·59	25·37	0	1859–71, 73–84	" "
Kaluga	2	54·31	36·16	525	1843, 53–63	" "
Kaminietz-Podolsk	2	48·40	26·34	722	1844–68, irreg.	" "
Kamyschin	2	50·5	45·24	69	1880–84	" "
Karabagh	2	44·37	34·24	164	1852–53, 60–67	" "
Karassinskoe	2	55·23	64·13	459	1869–73	" "
Kasan	2	55·47	49·8	262	1812–20, 27–84	" "
Kasan'sche Lehrfahrm	2	55·45	49·6	262?	1851–53, 63–73	" "
Katharinenstadt	2	51·43	46·45	56?	1883–84	" "
Kem	2	64·57	34·39	33	1863, 65–84	" "
Kerensk	2	52·42	43·3			" "
Kertch	2	45·21	36·29	33	1873–84	" "
Kharkov	2	50·1	36·14	394	1841–49	" "
Kherson	2	46·38	32·37	98	1825–52	" "
Kholm	2	57·6	31·10	328?	1856–61	" "
Kiew	2	50·26	30·31	591	1812–84, irreg.	" "
Kischinau	2	46·59	28·51	295	1844–84	" "
Kisil-Arwat	2	39·10	56·33			" "
Konstantinowskaja, Staniza	2	47·35	41·5	197?	1861–64	" "
Karostyschew	2	50·19	29·3		1883–84	" "
Kosmodemiansk	2	56·21	46·33	230	1856–69	" "
Kostroma	2	57·47	40·55	361	1842–47, 49–69	" "
Kotschetowskaja Staniza	2	47·33	40·52	197?	1850–55	" "
Kovno	2	54·54	23·53	230	1839–43, 45–46	" "
Krasnyj-Koljadin	2	50·56	33·3			" "
Kriwoi-Rog	2	47·54	33·20		1883–84	" "
Kronstadt	2	59·59	29·47	66	1844–84	" "
Kursk	2	51·45	36·8	689	1833–68, irreg.	" "

XIX. RUSSIA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′	ft.		
Kutais	2	42·16	42·42	459	1848–84, irreg.	Annalen des physikalischen Central-Observatoriums.
Ladowskaja Staniza	2	45·18	39·56		1877–84	
Lenkoran	2	38·46	48·51	−66	1847–56	" "
Lgov (Eisenbahnstation)	2	51·38	35·17	540?	1883–84	" "
Libau	2	56·30	21·1	33	1858–65, 67–84	" "
Livadia	2	43·0	35·0	505		" "
Livny	2	52·25	37·37		1883–84	" "
Ljublin	2	51·15	22·35	609?	1883–84	" "
Lodz	2	51·47	19·29			" "
Lomsha	2	53·11	22·5			" "
Lowitsch	2	52·7	19·57	236?	1883–84	" "
Lubahn	2	56·55	26·43	394?	1853–68	" "
Lugan	2	48·35	39·20	197	1837–84	" "
Luggenhusen	2	59·23	27·5	197	1849–61, 64–74	" "
Malyj-Usen	2	50·31	47·37		1882–84	" "
Mangliss	2	41·42	44·23	3002?	1883–84	" "
Marien-Kolonie	2	51·38	45·30	656?	1847–53, 70–84	" "
Melitopol	2	46·51	35·23		1883–84	" "
Mezen	2	65·50	44·16	53	1883–84	" "
Michailowskaja Staniza	2	43·19	45·10	820	1870–84	" "
Mitau	2	56·39	23·44	33	1823–84	" "
Mogtschenskoe	2	65·1	53·53			" "
Molitowka	2	56·17	43·57	206	1882–84	" "
Molodetschno	2	54·19	26·52	591	1870–84	" "
Morshansk	2	53·26	41·50	459	1848–60, irreg.	" "
Morshowez (L. H.)	2	66·45	42·29	98	1845–65, irreg.	" "
Moscow	2	55·46	37·40	525	1779–1884, ireg.	" "
" (Petow. Ak.)	2	55·50	37·33	558?	1879–84	" "
Mudjug (L. H.)	2	64·55	40·10	0	1840–54, 56–65	" "
Muldia	2	62·24	24·50	558?	1851–65	" "
Muonioniska	2	67·57	23·40	984?	1848–59	" "
Naronowo	2	58·33	32·44	558	1854–62	" "
Nijni Novgorod	2	56·20	44·0	459	1835–57, 72–84	" "
Nijni Tagilsk	2	57·55	59·53	591	1839–65	" "
Nikolaewskoe	2	51·38	45·27	614?	1879–84	" "
Nikolaiew	2	46·58	31·58	66	1824–84	" "
Nikolaievka	2	50·25	38·9	492?	1848–59	" "
Nishne-Tchirskaia-Staniza	2	48·20	43·8	295?	1848–64, 72	" "
Novaia Ladoga	2	60·7	32·19	33?	1877–84	" "
Nova Zembla	2	72·30	52·42	30		" "
Novgorod	2	58·31	31·18	164	1851–55, 57–61	" "
Novo-Oskol	2	50·46	37·52	459	1838–44	" "
Novorossijsk	2	44·43	37·47	0	1872–84	" "
Nowaja-Alexandrija	2	51·25	21·57	492	1871–84	" "
Nowotscherkask	2	47·25	40·6	131?	1850–66	" "
Odessa	2	46·29	30·44	230	1839–84, irreg.	" "
Orel	2	52·57	36·5	558	1838–63, irreg.	" "
Orenburg	2	51·46	55·7	361	1843–84	" "
Orlov (L. H.)	2	67·11	41·24	364	1843–54, 59–65	" "
Orlow	2	47·6	35·50	328?	1841–54	" "
Ostrog	2	50·20	26·33			" "
Otschakow	2	46·36	31·32	98	1863–69, 74–84	" "
Packerort (L. H.)	2	59·23	24·2	66	1865–84	" "
Pavlograd	2	48·32	35·52	328?	1850–54	" "
PAWLOWSK	1	59·41	30·29	133	1878–84	" "
Penza	2	53·11	45·1	623	1850–84, irreg.	" "
Pernau	2	58·23	24·30	33	1842–49	" "
Perm	2	58·1	56·16	427?	1866–70	" "

XIX. RUSSIA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N ° ′	E ° ′	ft.		
Petrozawodsk	2	61·47	34·23	164	1857–84	Annalen des physikalischen Central-Observatoriums.
Pjatigorsk	2	44·3	43·5	1673	1872–84	
Polibino	2	53·44	52·56	305?	1882–84	,, ,,
Poljanki	2	52·56	46·28	656?	1868–69, 71–84	,, ,,
Poltawa	2	49·35	34·34	459?	1848–65	,, ,,
Poni	2	42·0	43·20	3060	1882–84	,, ,,
Port Baltic	2	59·21	24·3	33	1839–84	,, ,,
Port Kunda	2	59·31	26·32	164	1849–58	,, ,,
Poti	2	42·9	41·37	0	1868–84	,, ,,
Prischib	2	45·3	38·55	121?	1881–84	,, ,,
Puolango	2	64·52	27·48	656?	1858–65	,, ,,
Pussen	2	57·20	22·1	66?	1853–84	,, ,,
Putiol	2	51·20	33·52	558?	1837–40	,, ,,
Radom	2	51·24	20·38			,, ,,
Rappel	2	59·1	24·47	197	1849–58	,, ,,
Rauge	2	57·44	26·57	492	1853–60	,, ,,
Redut-Kale	2	42·16	41·36	33	1847–54	,, ,,
Reo	2	58·19	22·30	33	1871–84	,, ,,
Reval	2	59·26	24·45	0	1806–13, 28–84	,, ,,
Revalstein (L. H.)	2	59·43	24·45	0	1859–71, 73–84	,, ,,
Riasan	2	54·38	39·45	361	1834–35, 71–73	,, ,,
Riga	2	56·57	24·6	33	1795–1884, ireg.	,, ,,
Roshdestwenskoe (Kostroma)	2	58·9	45·36	443?	1878–84	,, ,,
Roshdestwenskoe (Perm)	2	55·15	60·34			,, ,,
Rostov on the Don	2	47·13	39·43			,, ,,
Rovno	2	50·37	26·15		1883–84	,, ,,
Sackenhausen-Bächhof	2	56·51	21·13	33?	1863–72	,, ,,
St. Johannis	2	59·3	25·51	328	1867–84	,, ,,
ST. PETERSBURG	1	59·56	30·16	33	1743–1884, ireg.	,, ,,
St. Simonis	2	59·4	26·28	394	1849–61, 63–65	,, ,,
Samara	2	53·11	50·5	197?	1852, 54–84	,, ,,
Samara'sche Lehrfahrm	2	51·5	47·12	164?	1848–57	,, ,,
Samartyn	2	52·55	39·35	623?	1842–57	,, ,,
Sarapul	2	56·28	53·49	262?	1834–35, 41–50	,, ,,
Saratow	2	51·32	46·2	197	1836–84, irreg.	,, ,,
Sarepta	2	48·30	44·34	164?	1838–55	,, ,,
Schaitanka	2	47·41	37·5		1883–84	,, ,,
Schenkurok	2	62·6	42·55			,, ,,
Schlusselburg	2	59·57	31·2	36?	1877–84	,, ,,
Schmaisen	2	56·23	20·45	377?		,, ,,
Semettschino	2	53·30	42·37	377?	1880–84	,, ,,
Senniza	2	51·0	23·19			,, ,,
Sermaxa	2	60·28	33·5	49?	1878–84	,, ,,
Sevastopol	2	44·37	33·31	131	1824–84, irreg.	,, ,,
Shishginsk (L. H.)	2	65·12	36·51	98	1843–54, 57–65	,, ,,
Simbirsk	2	54·19	48·24	459	1855–64	,, ,,
Simferopol	2	44·57	34·6	853	1821–53, 66–72	,, ,,
Simnjaja-Solotiza	2	65·41	40·14	28?	1880–84	,, ,,
Sisjabskoe	2	65·5	53·51			,, ,,
Skopin	2	53·49	39·33	463?	1881–84	,, ,,
Slatoust	2	55·10	59·41	1345	1818–19, 37–84	,, ,,
Slobodka	2	62·53	42·42	66?	1881–84	,, ,,
Slobodskoi	2	58·44	50·12	328?	1841, 43–71	,, ,,
Sluzk	2	53·2	27·33			,, ,,
Solgalitsch	2	59·5	42·17			,, ,,
Solvitchegodsk	2	61·19	46·57	230?	1854–55, 57–62	,, ,,
Soschanskoe	2	49·34	28·55	932?	1878–84	,, ,,
Sotschi	2	43·34	39·42	66	1870–84	,, ,,

XIX. RUSSIA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′	ft.		
Staryi-Bykhov	2	53·31	30·16	513?	1876–84	Annalen des physikalischen Central-Observatoriums.
Stavropol	2	45·3	41·59	1804?	1854–59, 63–84	
Sukhum Kale	2	43·0	41·1	16	1872–84	,, ,,
Sumy	2	50·54	34·48			,, ,,
Surrop (L. H.)	2	59·28	24·24	66	1865–66, 72–84	,, ,,
Swalfer Ort (L. H.)	2	57·55	22·4	0	1865–84	,, ,,
Sweaborg	2	60·8	24·59	33?	1817–59, irreg.	,, ,,
Swislotsch	2	53·3	24·7	525?	1838–46	,, ,,
Taganrog	2	47·12	38·59	98	1816–33, 74–84	,, ,,
Tambov	2	52·43	41·28	558	1845–56, 58–60	,, ,,
Tchernigov	2	51·29	31·18	295	1865–66, 70–84	,, ,,
Temir-Chan-Schura	2	42·49	47·7	1394?	1882–84	,, ,,
Temnikov	2	54·38	43·12	394?	1850–56, 58–60	,, ,,
Theodossija	2	45·2	35·23	73?	1876–84	,, ,,
TIFLIS	1	41·43	44·47	1411	1844–84	,, ,,
Tuapsse	2	44·6	39·4		1876–84	,, ,,
Tzaritzin	2	48·42	44·31	98?	1836–54	,, ,,
Uelzen	2	57·53	26·37	459?	1853–59	,, ,,
Ufa	2	54·43	55·56	558?	1838–58, irreg.	,, ,,
Uralsk	2	51·11	51·22	164	1859–63, 67–69	,, ,,
,, (Muster Forstei)	2	51·43	51·49		1883–84	,, ,,
Urjupinskaja Staniza	2	50·45	42·0	525?	1858–62, 67–84	,, ,,
Urshum	2	57·7	50·1	262	1853–64	,, ,,
Usting Weliki	2	60·46	46·18	262?	1840–52	,, ,,
Ust-Medwidizkaja Staniza	2	49·35	42·45	328?	1850–59	,, ,,
Ust Sisolsk	2	61·40	50·51	328?	1817–67	,, ,,
Vladikawkaz	2	43·2	44·41	2231	1872–84	,, ,,
Vladimir	2	56·8	40·25	558?	1839–50	,, ,,
Vologda	2	59·14	39·53	361	1844–84, irreg.	,, ,,
Warsaw	2	52·13	21·2	394	1779–99, 1826–84	,, ,,
Wassilewitschi	2	52·16	29·48	449	1878–84	,, ,,
Wasil-Sursk	2	56·8	46·0	443	1883–84	,, ,,
Welikie-Luki	2	56·21	30·31	358	1880–84	,, ,,
Weliko-Anadolsk	2	47·41	37·26	738?	1881–84	,, ,,
Werchovashskoi	2	60·45	42·3		1852–58	,, ,,
Wesenberg	2	59·21	26·24	427?	1871–84	,, ,,
Wilna	2	54·41	25·18	394	1816–84	,, ,,
Windau	2	57·24	21·33	33	1862–66, 68–84	,, ,,
Wissimo-Schaitansk	2	57·40	59·30	906?	1878–84	,, ,,
Wolgsk	2	52·2	47·23	328?	1860–65	,, ,,
Wolkowyschki	2	54·39	23·2	230?	1869–84	,, ,,
Wolmar	2	57·32	25·26	164	1854–61, 64–65	,, ,,
Wologda'sche Lehrfahrm	2	59·25	38·53	394?	1847–55	,, ,,
Wolokolamsk	2	56·2	35·58	591?	1834–43	,, ,,
Woltchansk	2	50·17	36·57	328	1848–65	,, ,,
Woro	2	63·11	22·0	66?	1800–24	,, ,,
Woronesh	2	51·40	39·13	492	1862–84, irreg.	,, ,,
Woskressensk	2	53·7	56·12	656?	1853–59, 65	,, ,,
Wosnessenje	2	61·1	35·32	133?	1883–84	,, ,,
Wytegra	2	61·0	36·27	152?	1878–84	,, ,,
Yalta	2	44·30	34·11	131	1869–84	,, ,,
Yelabuga	2	55·45	52·4	197	1864–73	,, ,,

XX. FINLAND.

Abo	2	60·27	22·17	49	1858–84	Acta Soc. Sci. Fenn.
Biorneborg	2	61·30	21·41	49	1850–61	,, ,,
Brahestad	2	64·41	24·28	108	1874–80	,, ,,

XX. FINLAND—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′	ft.		
Eknœs	2	59·59	23·27	33	1850–57	Acta Soc. Sci. Fenn.
Fagervik i Finga	2	60·1	23·51	66	1851–54	,, ,,
Flomants	2	62·38	31·19	574	1880–84	,, ,,
Frederikshamn	2	60·34	27·12	49	1853–63	,, ,,
Hammarland	2	60·13	19·46	33	1850–58	,, ,,
Hangö (Lighthouse)	2	59·46	22·57	18	1866–84	,, ,,
Hangö (Town)	2	59·49	22·55	30	1877–84	,, ,,
Helsingfors	2	60·10	24·57	38	1850–84	,, ,,
Jyvaskyla	2	62·14	25·44	321	1865–84, irreg.	,, ,,
Kaiana	2	64·13	27·42	440	1850–80, irreg.	,, ,,
Karstula	2	62·52	24·47	394	1872–77	,, ,,
Keurn	2	62·15	24·42	361	1858–65	,, ,,
Kexholm	2	61·2	30·7	92	1871–79	,, ,,
Kittilä	2	67·40	25·3	568	1870–74	,, ,,
Kuopio	2	62·54	27·40	295	1850–77, 1884	,, ,,
Lampis	2	61·6	25·3	394	1870–84	,, ,,
Larsmo	2	63·45	22·46	33	1866–82	,, ,,
Lojo	2	60·15	24·0	167	1850–54	,, ,,
Mariehamn	2	60·6	19·57	27	1866–84	,, ,,
Marjaniemi	2	65·2	24·54	72	1874–84	,, ,,
Mustiala	2	60·49	23·47	405	1850–72, 81–84	,, ,,
Nyslott	2	61·52	28·51	262	1850, 52–55	,, ,,
Otava	2	61·39	27·2	486	1872, 75–84	,, ,,
Pyhäiärvi	2	63·40	25·52	545	1877–84	,, ,,
Runsala	2	60·26	22·7	16	1865–70, 72–3	,, ,,
Säbbskär	2	61·28	21·22	52	1876–84	,, ,,
Salo	2	60·22	23·9	33	1870–79	,, ,,
Seinäjoki	2	62·46	22·48	440	1870–73	,, ,,
Skälgrund	2	62·20	21·12	39	1876–84	,, ,,
Skälskär	2	60·24	19·37	26	1869–84	,, ,,
Sodankylä	2	67·24	26·36	492	1863, 1865–74	,, ,,
Söderskär	2	60·7	25·26	16	1866–84	,, ,,
Sordavala	2	61·42	30·42	97	1850–84	,, ,,
Tammerfors	2	61·30	23·45	300	1867–84, irreg.	,, ,,
Tohmajärvi	2	62·12	30·36	269	1873–4, 76–84	,, ,,
Torneä	2	65·51	24·9	30	1850–84, irreg.	,, ,,
Uleäborg	2	65·1	25·30	30	1850–84	,, ,,
Ulkokalla	2	64·22	23·34	52	1873–84	,, ,,
Viborg	2	60·43	28·46	23	1870–81, 1884	,, ,,
Wärtsilä	2	62·11	30·39	344	1873–77, 1884	,, ,,
Wasa	2	63·5	21·33	46	1871–84, irreg.	,, ,,
Wütasaari	2	63·4	25·52	344	1850–61	,, ,,

XXI. SPAIN.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
Albacete	2	39·0	1·52 W	2251	1865–84	Resu. de las Obs. Met.
Albarracin	2	40·25	1·8 W	3281?	1878–84	de Provincias.
Alcalá la Real	2	37·24	4·0 W	3248?	1882–84	,, ,,
Alcañiz	2	41·3	0·4 E		1882–84	,, ,,
Alicante	2	38·21	0·29 W	13	1865–84	,, ,,
Archidona	2	37·6	4·24 W	2165	1882–84	,, ,,
Avila	2	40·39	4·42 W	3609	1882–84	,, ,,
Badajoz	2	38·54	6·58 W	558	1865–84	,, ,,
Barbastro	2	42·2	0·5 E	1037	1882–84	,, ,,
Barcelona	2	41·22	2·9 E	69	1865–84	,, ,,
Bilbao	2	43·15	2·56 W	52	1865–84	,, ,,
Burgos	2	42·20	3·43 W	2822	1865–84	,, ,,
Cáceres	2	39·29	6·21 W	1148	1882–84	,, ,,

XXI. SPAIN—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N ° ′	° ′	ft.		
Cádiz	2	36·31	6·19 W		1882–84	Resu. de las Obs. Met. de Provincias.
Calatayud	2	41·21	1·42 W	1713?	1882–84	,, ,,
Cartagena	2	37·36	0·59 W	20	1877–84	,, ,,
Cazorla	2	37·55	3·1 W		1882–84	,, ,,
Ciudad Real	2	38·59	3·56 W	2247	1865–84	,, ,,
Corunna	2	43·22	8·24 W	82	1865–84	,, ,,
Escorial, El	2	40·37	4·13 W	3373	1870–84	,, ,,
Granada	2	37·11	3·39 W	2198	1865–84	,, ,,
Huesca	2	42·7	0·26 W	1598	1865–84	,, ,,
Igualada	2	41·33	1·32 E		1882–84	,, ,,
Jaca	2	42·36	0·34 W	2690	1882–84	,, ,,
Jaen	2	37·47	3·47 W	1926	1865–84	,, ,,
La Guardia	2	41·54	8·49 W	26	1882–84	,, ,,
Leon	2	42·36	5·33 W	2631	1865–84	,, ,,
Lerida	2	41·38	0·38 E	492	1882–84	,, ,,
Logrono	2	42·27	2·27 W	1220	1882–84	,, ,,
MADRID	1	40·24	3·42 W	2149	1865–84	,, ,,
Malaga	2	36·43	4·26 W	75	1878–84	,, ,,
Molina de Aragon	2	40·53	1·54 W	3465	1882–84	,, ,,
Murcia	2	37·59	1·9 W	138	1865–84	,, ,,
Olot	2	42·10	2·30 E	994	1882–84	,, ,,
Ona	2	42·44	3·26 W	1906	1882–84	,, ,,
Orduna	2	42·59	3·0 W		1882–84	,, ,,
Orense	2	42·20	6·15 W	472	1882–84	,, ,,
Oviedo	2	43·23	5·49 W	738	1865–84	,, ,,
Palencia	2	42·1	4·33 W	2461	1882–84	,, ,,
Palma	2	39·33	2·38 E	66	1865–84	,, ,,
Pamplona	2	42·49	1·39 W	1532	1882–84	,, ,,
Pontevedra	2	42·26	8·37 W	39	1882–84	,, ,,
Salamanca	2	40·58	5·40 W	2671	1865–84	,, ,,
SAN FERNANDO	2	36·28	6·13 W	92	1865–84	,, ,,
San Sebastian	2	43·19	2·0 W	82	1878–84	,, ,,
Santander	2	43·29	3·49 W		1878–84	,, ,,
Santiago	2	42·53	8·34 W	863	1865–84	,, ,,
Saragossa	2	41·38	0·53 W	656	1865–84	,, ,,
Segovia	2	40·57	4·8 W	3297	1882–84	,, ,,
Seville	2	37·23	6·1 W	98	1865–84	,, ,,
Soria	2	41·49	2·32 W	3504	1865–84	,, ,,
Sos	2	42·30	1·9 W			,, ,,
Tarifa	2	36·0	5·35 W	46	1865–84	,, ,,
Tarragona	2	41·7	1·12 E	387		,, ,,
Teruel	2	40·21	1·7 W	3005	1878–84	,, ,,
Valdesevilla	2	38·42	6·50 W	912	1882–84	,, ,,
Valencia	2	39·28	0·23 W	59	1865–84	,, ,,
Valladolid	2	41·39	4·43 W	2346	1865–84	,, ,,
Yecla	2	38·38	1·15 W	1969	1882–84	,, ,,

XXII. SWEDEN.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
			E	ft.		
Alderstugan	2	59·41	16·18		1881–84	Met. Iakttag. i. Sverige.
Askersund	2	58·53	14·55	351	1859–84	,, ,,
Bälinge	2	59·57	17·33		1881–84	,, ,,
Björkholm	2	57·20	12·22		1881–84	,, ,,
Bjuråker	2	61·52	16·36		1878–84	,, ,,
Dingtuna	2	59·34	16·25		1881–84	,, ,,
Falköping	2	58·10	13·34		1881–84	,, ,,
Falun	2	60·36	15·38	380	1860–84	,, ,,

XII. SWEDEN—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′	ft.		
Gefle	2	60·40	17·9	39	1859–84	Met. Iakttag. i. Sverige.
Godegård	2	58·44	15·8		1881–83	,, ,,
Göteborg	2	57·42	11·58	22	1859–84	,, ,,
Gysinge	2	60·17	16·54		1875–84	,, ,,
Halmstad	2	56·40	12·52	34	1859–84	,, ,,
Haparanda	2	65·50	24·9	30	1859–84	,, ,,
Helde	2	58·32	13·30		1881–84	,, ,,
Helmershus	2	57·10	14·3		1881–84	,, ,,
Hernösand	2	62·38	17·57	45	1859–84	,, ,,
Huså	2	63·32	13·7	1302	1877–84	,, ,,
Joçkmoçk	2	66·36	19·51	926	1860–84	,, ,,
Jönköping	2	57·47	14·11	310	1859–84	,, ,,
Kalmar	2	56·40	16·22	30	1859–84	,, ,,
Karesuando	2	68·26	22·28		1879–84	,, ,,
Karlshamn	2	56·10	14·52	31	1859–84	,, ,,
Karlstad	2	59·23	13·30	172	1859–84	,, ,,
Kilafors	2	61·13	16·37		1882–84	,, ,,
Kinnared	2	57·2	13·6		1882–84	,, ,,
Kristianstad	2	56·2	14·10	30	1878–84	,, ,,
Lillhärad	2	59·39	16·22		1881–84	,, ,,
Linköping	2	58·25	15·37	222	1859–84	,, ,,
Lund's Observatorium	2	55·42	13·12	124	1863–84	,, ,,
Nässjö	2	57·39	14·42		1882–84	,, ,,
Nora	2	59·31	15·3	308	1875–84	,, ,,
Nyköping	2	58·45	17·1	55	1859–84	,, ,,
Piteå	2	65·19	21·30	34	1859–84	,, ,,
Ronneby	2	56·13	15·18		1881–84	,, ,,
Skara	2	58·23	13·27	371	1859–84	,, ,,
Skeninge	2	58·24	15·6		1881–84	,, ,,
Spårhult	2	58·35	13·40		1881–84	,, ,,
Stensele	2	65·5	17·12	1106	1860–84	,, ,,
Stockholm: Experimentalfältet	2	59·21	18·4		1881–84	,, ,,
Stockholm: Observatorium	2	59·20	18·4	146	1863–84	,, ,,
Strömstad	2	58·56	11·11	29	1870–84	,, ,,
Stum	2	56·59	12·33		1881–84	,, ,,
Sveg	2	62·2	14·23		1875–84	,, ,,
Tierp	2	60·17	17·28		1881–84	,, ,,
Umeå	2	63·49	20·18	41	1859–84	,, ,,
Upsala	1	59·52	17·38		1855–84	Résultats, Observations, Mét. Horaires, Bulletin Mét. Mensuel.
Vadstena	2	58·27	14·54		1881–83	Met. Iakttag. i. Sverige.
Venersborg	2	58·23	12·20	178	1859–84	,, ,,
Vesterås	2	59·37	16·33	60	1859–84	,, ,,
Vestervik	2	57·46	16·39	44	1859–84	,, ,,
Vexjö	2	56·53	14·49	552	1859–84	,, ,,
Visby	2	57·39	18·20	52	1859–84	,, ,,
Åkerlänna	2	60·1	17·23		1881–84	,, ,,
Örebro	2	59·16	15·13	101	1859–84	,, ,,
Östersund	2	63·11	14·38	972	1860–84	,, ,,
Östra Karup	2	56·25	12·58		1881–84	,, ,,
Öxnäs	2	58·40	12·5		1882–84	,, ,,

XXIII. SWITZERLAND.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E			
		° ′	° ′	ft.		
Aarau	2	47·23	8·2	1306	1864–84	Schweiz. meteor. Beobacht.
Affoltern, i/E	2	47·6	7·45	2608	1864–84	„ „
Aigle	2	46·19	6·58	1394	1881–4	„ „
Airolo	2	46·31	8·36	3786	1868–71, 73–84	„ „
Altdorf	2	46·53	8·39	1588	1864–84	„ „
Altstätten	2	47·23	9·33	1506	1864–84	„ „
Andermatt	2	46·38	8·35	4751	1864–84	„ „
Auen, Linththal	2	46·54	8·59	2152	1864–84	„ „
Baden	2	47·29	8·19	1257	1882–4	„ „
Basle	2	47·33	7·35	912	1864–84	„ „
Beatenberg	2	46·41	7·48	3773	1864–84	„ „
Bellinzona	2	46·12	9·1	804	1864–73, 76–83	„ „
BERNE	1	46·57	7·26	1880	1864–84	„ „
Bernhardin	2	46·30	9·13	6791	1864–84	„ „
Bernina (la Rösa)	2	46·27	10·3	6145	1864–70	„ „
„ (Hospice)	2	46·27	10·1	7677	1871–73, 78–79	„ „
Bevers	2	46·33	9·53	5627	1864–84	„ „
Bex	2	46·15	7·1	1434	1864–73	„ „
Biasca	2	46·21	8·58	978	1876–83	„ „
Böttstein	2	47·34	8·13	1214	1878–84	„ „
Bötzberg	2	47·30	8·9	1893	1864–68	„ „
Braggio	2	46·18	9·7	4200	1884	„ „
Brévine	2	46·58	6·37	3465	1872–3	„ „
Brienz	2	46·46	8·1	1923	1864–70	„ „
Brusio	2	46·15	9·58	2549	1864–73	„ „
Burgdorf	2	47·4	7·37	1804	1870–75	„ „
Castasegna	2	46·20	9·31	2297	1864–84	„ „
Cenere, Monte	2	46·8	8·54	1804	1876–78	„ „
Château d'Oex	2	46·29	7·7	3182	1879–84	„ „
Chaumont	2	47·1	6·59	3701	1864–84	„ „
Chaux-de-Fonds	2	47·6	6·50	3215	1864–66	„ „
Chur	2	46·51	9·32	1936	1864–78	„ „
Churwalden	2	46·47	9·32	3980	1864–73	„ „
Cuves (la Tine)	2	46·29	7·2	2897	1880–84	„ „
Davos-Platz	2	46·48	9·49	5118	1866–84, irreg.	„ „
Diessenhofen	2	47·42	8·45	1362	1881–4	„ „
Dizy	2	46·38	6·30	1929	1864–6	„ „
Dusnang	2	47·26	8·57	1952	1877–80	„ „
Ebnat	2	47·16	9·8	2123	1879–84	„ „
Einsiedeln	2	47·8	8·45	2986	1864–84	„ „
Elm	2	46·55	9·10	3153	1878–84	„ „
Engelberg	2	46·49	8·25	3350	1864–84	„ „
Engstlen-Alp	2	46·47	8·20	6037	1864–5, 69	„ „
Faido	2	46·29	8·48	2490	1864–6, 76–84	„ „
Frauenfeld	2	47·34	8·54	1401	1864–73, 79–84	„ „
Fribourg (Bourguillon)	2	46·48	7·10	2152	1864–84, irreg.	„ „
Frutigen	2	46·35	7·39	2100	1871–73	„ „
Gäbris	2	47·23	9·28	4111	1871–84	„ „
Generoso, Monte	2	45·55	9·0	4016	1869–73	„ „
Göschenen	2	46·40	8·35	3701	1872–3, 76–84	„ „
GENEVA	1	46·12	6·9	1339	1864–84	„ „
Gersau	2	46·59	8·31	1444	1866–84	„ „
Glarus	2	47·3	9·4	1545	1864–7, 71–84	„ „
Glyss	2	46·17	7·58	2257	1864–66	„ „
Gotthard	2	46·33	8 34	6890	1864–75, 77–84	„ „
Grächen	2	46·12	7·51	5354	1864–82	„ „
Grimsel-Hospice	2	46·34	8·20	6148	1864–84	„ „
Grindelwald	2	46·38	8·2	3468	1865–69	„ „
Gurzelen	2	46·46	7·31	2238	1872–80	„ „

XXIII. SWITZERLAND—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N ° ′	E ° ′	ft.		
Guttannen	2	46·39	8·17	3511	1872–3, 76–84	Schweiz. meteor. Beobacht.
Ilanz	2	46·47	9·13	2310	1864–66	" "
Interlaken	2	46·41	7·52	1864	1864–84	" "
Julier	2	46·28	9·44	7359	1864–84	" "
Kaiserstuhl	2	47·35	8·25	1188	1866–69	" "
Klosters	2	46·52	9·53	3960	1864–77	" "
Königsfelden	2	47·29	8·13	1217	1864–66	" "
Kreuzlingen	2	47·39	9·11	1404	1864–76, 78–84	" "
Lausanne	2	46·31	6·37	1663	1874–84	" "
Leukerbad	2	46·23	7·37	4642	1884	" "
Liestal	2	47·29	7·44	1066	1879–84	" "
Linth Colony	2	47·9	9·2	1424	1872–4, 77–84	" "
Locarno (Muralto)	2	46·10	8·48	689	1864, 76–84	" "
Lohn	2	47·45	8·40	2116	1864–80	" "
Lottigna	2	46·28	8·56	2152	1878–84	" "
Lugano	2	46·0	8·57	902	1864–84	" "
Lucerne, Sonnenberg	2	47·3	8·17	1936	1870–84	" "
Lucerne, Stadt	2	47·3	8·19	1490	1879–84	" "
Marchairuz	2	46·33	6·15	4767	1864–66	" "
Marschlins	2	46·57	9·35	5069	1864–83	" "
Martigny (Bourg)	2	46·6	7·3	1634	1864–81, 84	" "
Mendrisio	2	45·52	8·59	1165	1864–66	" "
Morges	2	46·30	6·29	1247	1864–66	" "
Muri	2	47·16	8·20	1585	1864–84	" "
Murten	2	46·55	7·7	1535	1871–73	" "
Neuchâtel	2	47·0	6·57	1601	1864–84	" "
Olten	2	47·21	7·54	1289	1864–84	" "
Platta (Medels)	2	46·39	8·51	4524	1864–74, 76–84	" "
Pontresina	2	46·30	9·54	5922	1873–76, 79–84	" "
Ponts, les	2	47·0	6·44	3356	1866–70	" "
Porrentruy	2	47·25	7·5	1526	1864–77	" "
Ragatz	2	47·1	9·29	1775	1870–84	" "
Rathhausen	2	47·16	8·18	1585	1864–67	" "
Reckingen	2	46·28	8·14	4426	1864–76, 81–4	" "
Reichenau	2	46·29	8·48	2395	1864–84	" "
Reidenbach	2	46·38	7·22	2854	1873–74	" "
Remüs	2	46·50	10·23	4085	1864–68	" "
Rheinfelden	2	47·33	7·47	863	1882–4	" "
Righi-culm	2	47·3	8·30	5873	1864—84, irreg.	" "
Rivera-Bironico	2	46·7	8·55	1558	1884	" "
Rorschach	2	47·29	9·30	1493	1869–75, 83–4	" "
Saanen	2	46·29	7·15	3356	1872, 80–84	" "
Saint-Imier	2	47·9	7·10	2733	1864–68	" "
Sainte-Croix	2	47·49	6·30	3583	1864–75	" "
St. Bernard	1	45·52	7·11	8130	1864–84	" "
St. Gallen	2	47·26	9·23	2231	1864–84	" "
St. Moritz	2	46·30	9·50	6020	1875–79	" "
St. Vittore	2	46·14	9·6	879	1868–84	" "
Sargans	2	47·3	9·26	1644	1864–73, 76–84	" "
Schaffhausen	2	47·42	8·38	1522	1864–71, 75–84	" "
Schöneck	2	46·57	8·30	2264	1871–73	" "
Schuls	2	46·48	10·18	4078	1868–71, 81–4	" "
Schwarzenburg	2	46·49	7·21	2641	1867–69, 71–73	" "
Schwytz	2	47·1	8·39	1795	1864–73, 77–84	" "
Seelisberg	2	46·58	8·35	2756	1871–73	" "
Sentier, le	2	46·36	6·14	3360	1864–66	" "
Sentis	2	47·15	9·20	8094	1882–4	" "
Sépey	2	46·22	7·3	3461	1881–2, 4	" "
Sils-Maria	2	46·26	9·46	5938	1864–84	" "

XXIII. SWITZERLAND—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N. ° ′	E. ° ′	ft.		
Simplon	2	46·15	8·2	6588	1864–73	Schweiz. meteor. Beobacht.
Sion	2	46·14	7·21	1772	1864–84	" "
Solothurn	2	47·13	7·32	1555	1864–73	" "
Splügen	2	46·33	9·19	4826	1864–83	" "
Stalla	2	46·28	9·38	5840	1864–67	" "
Stanz	2	46·57	8·22	1496	1864–6, 68	" "
Sursee	2	47·10	8·6	1657	1867–84	" "
Thun	2	46·46	7·37	1854	1875–84	" "
Thusis	2	46·41	9·26	2333	1864–75	" "
Trogen	2	47·25	9·28	2874	1864–84	" "
Uetliberg	2	47·21	8·30	2868	1864–72, 84	" "
Val Sainte	2	46·39	7·11	3386	1866–68	" "
Vernex	2	46·26	6·54	1263	1864–77	" "
Viznau	2	47·1	8·29	1444	1872–84	" "
Vuadens	2	46·37	7·1	2707	1864–83	" "
Wald	2	47·16	8·55	2037	1879–84	" "
Wasen	2	46·43	8·35	2789	1876–82	" "
Weissenstein	2	47·15	7·30	4232	1864–68, 82–4	" "
Wiesen	2	46·42	9·43	4770	1882–4	" "
Wildhaus	2	47·12	9·21	3609	1864–6, 80–4	" "
Winterthür	2	47·30	8·44	1480	1864–84	" "
Zermatt	2	46·8	7·45	5292	1864–67	" "
Zernetz	2	46·42	10·6	4843	1864–68	" "
Zug	2	47·10	8·31	1444	1864–6, 73–77	" "
Zürich	2	47·23	8·33	1542	1864–84	" "
Zurzach	2	47·35	8·17	1165	1864–66	" "

XXIV. TURKEY.

Constantinople	2	41·0	28·59		1857–69	An. de la Soc. Met. de France.
Durazzo	2	41·19	19·28	22	1869–72, 73–77	Zeit. für Met. XIX. p. 227.
Janina	2	39·47	20·55	1595		" XI. p. 316.

ASIA.

XXV. ASIA (GENERAL).

ARABIA.						
Aden	2	12·45	45·3	94	1880–84	Report on the Met. of India.
Muscat	2	23·38	58·32		1863–65	Zeit. für Met. XVI. p. 6.
ASIA MINOR.						
Bagdad	2	33·21	44·26			
Beyrout	2	33·54	35·29	98	1863–70, 76–84	Jahr. d. K. K. Cent. Anst.
Famagusta	2	35·7	33·57	75	1881–84	Rep. of San. Com. Cyprus.
Jerusalem	2	31·47	35·13	2500	1865–81	Journ. Scot. Met. Soc.
Kyrenia	2	35·21	33·19	59	1881–84	Rep. of San. Com. Cyprus.
Larnaca	2	34·54	33·37	39	1881–84	" "
Nicosia	2	35·11	33·22	508	1881–84	" "
Papho	2	34·45	32·25	226	1881–84	" "
Scio	2	38·22	26·6		1854–56	Zeit. für Met. VIII. p. 121.
Smyrna	2	38·26	27·10		1843–70, irreg.	" "
Trebizond	2	41·1	39·45	79		
CHINA.						
Kelung	2	25·20	121·46	33	1873–84	Ann. des Physik. Cent. Observ. St. Petersburg.
Macao	2	22·10	113·32	46	1882–84	Ann. do Obs. do Infante D. Luiz.

XXV. ASIA (GENERAL)—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
CHINA. (*Continued.*)		N ° ′	E ° ′	ft.		
Neu-chwang	2	40·57	121·27		1861–62	Zeit. für Met. VII. p. 7.
Pekin	2	39·57	116·29	131	1841–84, irreg.	Ann. des Physik. Cent. Observ. St. Petersburg.
Si-wan-tse	2	40·59	115·18	3904	1873–84	" "
Taku	2	38·59	117·40	33	1873–84	" "
Urga	2	47·55	106·51	3773	1869–84	" "
Yarkand	2	38·25	77·16		1873–75	Indian Met. Memoirs.
ZI-KA-WEI	1	31·13	121·26	23	1872–84	Bulletin Mensuel des Obs. Mag. et Met. de Zi-ka-Wei.
JAPAN.						
Aomori	2	40·51	140·45	32	1882–84	I. M. Observatory, Tokei.
Hakodati	2	41·48	140·47	131	1859–64	Ann. des Physik. Cent. Observ. St. Petersburg.
Hiroshima	2	34·20	132·27	14	1879–84	I. M. Observatory, Tokei.
Kanasawa	2	36·33	136·40	95	1882–84	" "
Kioto	2	35·1	135·46	162	1881–84	" "
Kochi	2	33·33	133·34	20	1882–84	" "
Nagasaki	2	32·44	129·52	189	1880–84	" "
Niigata	2	37·55	139·3	32	1881–84	" "
Nobiru	2	38·23	141·12	15	1881–84	" "
Osaka	2	34·42	135·30	14	1882–84	" "
Tokei	2	35·40	139·45	63	1876–84	" "
Wakayama	2	34·14	135·9	48	1880–84	" "
PERSIA.						
Bushire	2	28·59	50·49	25	1878–84	Report on the Met. of India.
Teheran	2	35·41	51·25	3714?	1883–84	Ann. des physik. Cent. Observ. St. Petersburg.
SIAM.						
Bangkok	2	11·45	100·30		1858–61, 63–68	Quarterly Journal, p. 82.

XXVI. ASIATIC RUSSIA.

Akmolinsk	2	51·12	71·23	1017	1870–84	Annalen des physikalischen Central Observatoriums.
Alexandrowka (Saghalien)	2	50·50	142·7	53	1881–84	
Alexandrowskij Post....	2	51·28	140·50	45		" "
Andidschan	2	40·48	72·22	1512	1882–84	" "
Ashurada	2	36·54	53·57	–66	1849–84, irreg.	" "
Askold	2	42·44	132·21	84	1876–84	" "
Auli ata	2	42·53	71·23	2625?	1870–84	" "
Barnaul	2	53·20	82·47	459	1838–84	" "
Behring Island	2	55·22	166·0			" "
Berezov	2	63·54	65·4	98?	1832–50	" "
Büsk	2	52·32	85·16			" "
Blagovestchensk	2	50·15	127·37	558	1859–84, irreg.	" "
Dudinskoe	2	70·30	83·10			" "
Dui (L. H.)...........	2	50·50	142·26	361	1860–61, 63–84	" "
Fort Alexandrovsk	2	44·27	50·8	–33	1849–84	" "
Fort Perovsky	2	44·51	65·27	394	1856–58, 62–68	" "
Goldwäsche Wosnesensk	2	58·46	115·20	2625	1858–68	" "

XXVI. ASIATIC RUSSIA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N ° ′	E ° ′	ft.		
Goltschicha	2	71·40	83·25			Annalen des physikalischen Central Observatoriums.
Gultscha	2	40·19	73·24	5499?	1881–84	,, ,,
Irgis (Fort Uralsk)	2	48·37	61·16	361	1863–84	,, ,,
Irkutsk	2	52·17	104·22	1509	1830–84, irreg.	,, ,,
Irkutsk(Training School)	2	52·16	104·16	1537	1879–84	,, ,,
Ishim	2	56·6	69·22	328	1847–61	,, ,,
Karakol	2	42·30	77·26	5400?	1882–84	,, ,,
Karaulnij-Jar	2	57·36	67·20		1880–84	,, ,,
Kasalinsk	2	45·46	62·7	197?	1855–84, irreg.	,, ,,
Khokand	2	40·32	70·57	1289	1882–84	,, ,,
Kiachta	2	50·20	106·35	2525?	1876–84	,, ,,
Kljutschewoe (Dschisak)	2	40·7	67·48		1882–84	,, ,,
Kopal	2	45·8	79·3		1883–84	,, ,,
Krasnoiarsk	2	56·1	92·53	558	1838–47, 68–73	,, ,,
Krasnovodsk	2	40·0	52·59	−66	1869–71, 76–84	,, ,,
Kuldja	2	43·56	80·58	1706	1853–60, irreg.	,, ,,
Kurgan	2	55·26	65·23	295?	1832–44, 51–53	,, ,,
Margelan	2	40·28	71·43	1857?	1880–84	,, ,,
Marinsk	2	56·18	87·44			,, ,,
Mokroussowo	2	55·47	66·48		1881–84	,, ,,
Namangan	2	41·0	71·41	1444?	1878–84	,, ,,
Narin	2	59·21	80·16	197?	1865–84	,, ,,
Nertchinsk (Hüttenwerk)	2	51·19	119·37	2165	1839–45, 47–84	,, ,,
Nertchinsk (Stadt)	2	51·58	116·35	1969?	1848–58	,, ,,
Nikolaievsk-on-Amoor	2	53·8	140·43	66?	1854–84	,, ,,
Nukus	2	42·27	59·37	230	1874–84	,, ,,
Obdorsk	2	66·31	66·35	60	1882–84	,, ,,
Okhotsk	2	59·21	143·17	33	1843–52	,, ,,
Ossh	2	40·33	72·47	3940?	1881–84	,, ,,
Pendshekent	2	39·28	67·33	3163?	1880–84	,, ,,
Petro-Alexandrowsk	2	41·28	61·5	328	1874–84	,, ,,
Petropalovsk	2	51·16	109·3	2526?	1830–39	,, ,,
Petropaulovski	2	53·0	158·48	33	1828, 43–53	,, ,,
Port Ayan	2	56·28	138·17	33	1844–45, 47–53	,, ,,
Post-Korssakowskij	2	46·39	142·48	66?	1878–84	,, ,,
Preobraiensk	2	60·0	107·56	1055?	1882–84	,, ,,
Puzylowka	2	43·40	131·20	551?		,, ,,
Raimsk (Fort Aralsk)	2	46·4	61·47	164	1848–55	,, ,,
St. Olga	2	43·44	135·20	149	1876–84	,, ,,
Saissanskij-Post	2	47·28	84·51	2008?	1882–84	,, ,,
Salair	2	54·15	85·47	1116	1874–84	,, ,,
Samaraewskoe	2	56·9	63·13			,, ,,
Saran-Paul	2	64·13	61·0		1883–84	,, ,,
Selenginsk	2	51·6	106·53	1870	1854–68	,, ,,
Semipalatinsk	2	50·24	80·13	591	1854–70, 75–84	,, ,,
Skryplew	2	43·2	131·58	145?	1883–84	,, ,,
Staro-Ssidorowa	2	55·26	65·10	322?	1880–84	,, ,,
Surgut	2	61·21	72·40			,, ,,
Tara	2	56·54	74·17	230?	1832–41	,, ,,
Tashkend	2	41·19	69·16	1476	1867–84	,, ,,
Tashkend (Obser.)	2	41·20	69·18	1606?	1877–84	,, ,,
Tashkend (Seminar.)	2	41·19	69·16	1516?	1882–84	,, ,,
Tobolsk	2	58·12	68·14	164?	1832–62, 64	,, ,,
Tomsk	2	56·30	84·58	230	1837–84, irreg.	,, ,,
Turinsk	2	58·3	63·40	230?	1843–84, irreg.	,, ,,
Turkestan	2	43·18	68·17	778?	1882–84	,, ,,
Ulala	2	51·59	86·2		1878–84	,, ,,
Vladivostock	2	43·9	132·0	98	1860–61, 72–84	,, ,,
Yakutsk	2	62·1	129·42	525	1829–73, irreg.	,, ,,
Yeniseisk	2	58·27	92·6	262	1853–84, irreg.	,, ,,

XXVII. INDIA.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	E	ft.		
		° ′	° ′			
Assam.						
Dhubri	2	26·7	89·50	115	1881–84	Report of the Met. of India.
Sibsagar	2	26·59	94·40	333	1874–84	" "
Silchar	2	24·49	92·50	104	1869–84	" "
Bay Islands.						
Nancowry	2	8·0	93·46	81	1873–84	" "
Port Blair	2	11·41	92·2	61	1868–84	" "
Beluchistan.						
Quetta	2	30·11	67·3	5500	1878–84	" "
Bengal.						
Berhampore	2	24·6	88·17	66	1868–84	" "
Burdivan	2	23·14	87·54	99	1873–84	" "
Calcutta (Alipore)	1	22·33	88·21	21	1853–84	" "
Chittagong	2	22·21	91·50	87	1871–84	" "
Cuttack	2	20·29	85·54	80	1868–84	" "
Dacca	2	23·43	90·27	35	1867–84	" "
Darjeeling	2	27·3	88·18	7421	1868–84	" "
Durbhanga	2	26·0	86·0	166	1875–84	" "
False Point	2	20·20	86·47	21	1867–84	" "
Gya	2	24·42	85·2	375	1871–84	" "
Hazaribagh	2	24·0	85·24	2007	1867–84	" "
Jessore	2	23·9	89·7	33	1867–84	" "
Patna	2	25·37	85·8	183	1868–84	" "
Purneah	2	25·50	87·34	125	1874–84	" "
Saugor Island	2	21·39	88·5	25	1867–84	" "
Berars.						
Akola	2	20·42	77·4	930	1875–84	" "
Amraoti	2	20·55	77·43	1213	1875–84	" "
Buldana	2	20·34	76·14	2132	1876–84	" "
Chikalda	2	21·24	77·22	3656	1876–84	" "
Bombay.						
Belgaum	2	15·52	74·42	2550	1875–84	" "
Buhj	2	23·15	69·42	395	1875–84	" "
Bombay	1	18·54	72·49	37	1847–84	" "
Deesa	2	24·16	72·14	466	1875–84	" "
Hyderabad	2	25·25	68·27	134	1875–84	" "
Jacobabad	2	28·24	68·18	186	1875–84	" "
Karwar	2	14·8	74·2	44	1878–84	" "
Kurrachee	2	24·47	67·4	49	1875–84	" "
Malegaum	2	20·34	74·22	1430	1876–84	" "
Poona	2	18·28	74·10	1849	1875–84	" "
Rajkot	2	22·17	70·52	429	1875–84	" "
Ratnagiri	2	17·6	73·23	110	1875–84	" "
Scholapur	2	17·41	75·56	1590	1875–84	" "
Surat	2	21·13	72·46	36	1875–84	" "
Burma.						
Akyab	2	20·28	92·57	20	1867–84	" "
Bassein	2	16·4	94·50	35	1875–84	" "
Diamond Island	2	15·52	94·19	41	1875–84	" "

XXVII. INDIA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
BURMA. (*Continued.*)		N	E			
		° ′	° ′			
Mergui	2	12·11	98·38	96	1875–84	Report of the Met. of India.
Moulmein	2	16·29	97·40	94	1875–84	" "
Rangoon	2	16·46	96·12	41	1875–84	" "
Thyetmio	2	19·22	95·12	134	1875–84	" "
Tounghoo	2	18·57	96·24	169	1876–84	" "
CASHMERE.						
Leh	2	34·10	77·42	11,538	1875–84	" "
CENTRAL INDIA.						
Indore	2	22·44	75·53	1823	1875–84	" "
Neemuch	2	24·25	75·0	1639	1875–84	" "
Nowgong	2	25·2	79·29	757	1875–84	" "
Sutna	2	24·34	80·52	1040	1875–84	" "
CENTRAL PROVINCES.						
Chanda	2	19·56	79·19	652	1875–84	" "
Hoskangabad	2	22·45	77·46	1020	1875–84	" "
Jubbulpore	2	23·9	79·59	1341	1869–84	" "
Khandwa	2	21·49	76·23	1024	1875–84	" "
Nagpur	2	21·9	79·11	1025	1869–84	" "
Pachmarhi	2	22·28	78·28	3528	1875–84	" "
Raipur	2	21·15	81·41	960	1875–84	" "
Sambalpur	2	21·31	81·1	451	1875–84	" "
Saugor	2	23·49	78·48	1769	1879–84	" "
Seoni	2	20·6	79·6	2030	1871–84	" "
Sironcha	2	18·51	80·0	401	1875–84	" "
MADRAS, MYSORE AND COORG.						
Bangalore	2	12·59	77·38	2981	1870–84	" "
Bellary	2	15·9	76·57	1455	1871–84	" "
Cochin	2	9·58	76·17	11	1871–84	" "
Coimbatore	2	11·0	77·00	1348	1870–84	" "
Madras	2	13·5	80·17	22	1860–84	" "
Madura	2	9·55	78·10	448	1870–84	" "
Mangalore	2	12·52	74·54	52	1878–84	" "
Masulipatam	2	16·9	81·12	10	1870–84	" "
Mercara	2	12·26	75·48	3695	1875–84	" "
Negapatam	2	10·46	79·53	15	1870–84	" "
Salem	2	11·39	78·12	940	1870–84	" "
Secunderabad	2	17·27	78·33	1787	1870–84	" "
Trichinopoly	2	10·50	78·44	275	1870–84	" "
Vizagapatam	2	17·42	83·22	31	1870–84	" "
Wellington	2	10·22	76·50	6200	1871–84	" "
NEPAL.						
Katmandu	2	27·42	85·12	4361	1880–84	" "
NORTH-WEST PROVINCES, AND OUDH.						
Agra	2	27·10	78·5	555	1875–84	" "
Allahabad	2	25·26	81·52	307	1875–84	" "
Bareilly	2	28·21	79·27	568	1875–84	" "
Benares	2	25·20	83·2	267	1868–84	" "

XXVII. INDIA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
NORTH-WEST PROVINCES AND OUDH. (*Continued.*)		N ° ′	E ° ′	ft.		
Chakrata	2	30·40	77·55	7052	1875–84	Report of the Met. of India.
Dehra	2	30·20	78·8	2232	1875–84	
Ghazipur	2	25·35	83·39	220	1882–84	,, ,,
Gorakhpur	2	26·46	83·18	256	1875–84	,, ,,
Jhansi	2	25·27	78·37	855	1875–84	,, ,,
Lucknow	2	26·50	81·0	369	1872–84	,, ,,
Meerut	2	29·41	77·41	737	1873–84	,, ,,
Paori	2	30·8	78·55	5103	1881–84	,, ,,
Pithoragarh	2	29·35	80·15	5373	1881–84	,, ,,
Ranikhet	2	29·38	79·29	6069	1873–84	,, ,,
Roorkee	2	29·52	77·56	887	1867–84	,, ,,
PUNJAB.						
Delhi	2	28·40	77·16	718	1875–84	,, ,,
Dera Ismail Khan	2	32·0	71·5	573	1875–84	,, ,,
Lahore	2	31·34	74·20	732	1873–84	,, ,,
Ludhiana	2	30·55	75·54	812	1875–84	,, ,,
Mooltan	2	31·10	71·33	420	1875–84	,, ,,
Murree	2	33·40	73·8	6344	1875–84	,, ,,
Peshawar	2	34·2	71·37	1110	1875–84	,, ,,
Rawalpindi	2	33·4	73·5	1652	1875–84	,, ,,
Sialkot	2	32·29	74·35	829	1875–84	,, ,,
Simla	2	31·6	77·12	7020	1880–84	,, ,,
Sirsa	2	29·32	75·6	662	1875–84	,, ,,
RAJPUTANA.						
Ajmere	2	28·26	74·37	1611	1875–84	,, ,,
Bickaneer	2	27·59	73·14	744	1875–84	,, ,,
Jeypore	2	26·55	75·50	1431	1881–84	,, ,,
Mount Abu	2	24·36	72·45	3945	1877–84	,, ,,
Puchbubra	2	25·55	72·18	399	1880–84	,, ,,
Sambhar	2	26·55	75·14	1254	1875–84	,, ,,

XXVIII. CEYLON.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
Anuradhapura	2	8·22	80·23	312	1871–84	Administration Reports.
Badulla	2	6·59	81·5	2225	1877–84	,, ,,
Batticaloa	2	7·43	81·44	26	1871–84	,, ,,
Colombo	2	6·56	79·59	40	1869–84	,, ,,
Galle	2	6·1	80·14	48	1869–84	,, ,,
Hakgala	2	6·55	80·49	5581	1883–84	,, ,,
Hambantota	2	6·7	81·7	40	1870–84	,, ,,
Jaffna	2	9·40	79·56	9	1870–84	,, ,,
Kandy	2	7·18	80·40	1650	1869–84	,, ,,
Kurunegala	2	7·29	80·22	?	1874–84	,, ,,
Mannar	2	8·59	79·55	12	1870–84	,, ,,
Nuwara Eliya	2	6·59	80·5	6240	1870–84	,, ,,
Puttalam	2	8·2	79·50	11	1870–84	,, ,,
Ratnapura	2	6·42	80·24	109	1871–84	,, ,,
Trincomalee	2	8·33	81·15	175	1881–84	,, ,,
Vavonia-Vilan Kulam	2	8·46	83·29	?		,, ,,

AFRICA.

XXIX. AFRICA (GENERAL).

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
NORTH.						
Alexandria	2	31·12 N	29·52 E	62	1875–84	Jahr. d. K. K. Cent. Anst.
Cairo	2	30·5 N	36·17 E	96	1857–61, 68–74	Zeit. für Met. VII. p. 65 and XII. p. 93.

XXIX. AFRICA (GENERAL)—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
NORTH. (*Continued.*)		° ′	° ′	ft.		
Kosseir	2	26·5 N	34·16 E		1872–73	Zeit. für Met. XII. p. 225.
Mogador	2	31·30 N	9·45 W	54	1866–71	„ „ VIII. p. 8.
EAST.						
Zanzibar	2	6·10 S	39·11 E	23	1875–81	Quarterly Journal.
SOUTH.						
Aliwal North	2	30·43 S	26·43 E	4400	1876–84	Report of Met. Commission of Cape of Good Hope.
Beaufort West	2	32·21	22·37	2850	1882–84	
Bloemfontein	2	28·56	26·18	4500	1876–84	
Brakfontein	2	31·52	23·0	4100	1881–84	„ „
Cape L'Agulhas	2	34·55	20·18	55	1881–84	„ „
Cape St. Francis	2	34·10	24·50	20	1880–84	„ „
Cape Town (Royal Observatory)	2	33·56	18·19	37	1827–84	„ „
Ceres	2	33·22	19·20	1700	1882–84	„ „
Cradock	2	32·11	25·38	2856	1881–84	„ „
East London	2	32·2	27·55	104	1877–84	Report of Met. Commission of Cape of Good Hope.
Graaff-Reinet	2	32·16	24·34	2500	1863–84	
Graham's Town	2	33·20	26·33	1800	1878–84	
Kimberley	2	28·45	25·0		1876–84	„ „
King William's Town	2	32·51	27·22	1314	1875–84	„ „
Lovedale	2	32·46	26·51	1750	1877–84	„ „
Mossel Bay	2	34·11	22·9	105	1862–84	„ „
Port Elizabeth	2	33·57	25·37	180	1866–84	„ „
Pretoria	2	25·45	28·50	4463	1875–78	Zeit. für Met. XVII. p. 19.
Prince Albert	2	33·14	22·0	2100	1882–84	Report of Met. Commiss.
Queenstown	2	31·51	26·51	3500	1880–84	„ „
Simon's Town	2	34·12	18·26	20	1862–84	„ „
Somerset, East	2	32·44	25·35	2400	1875–84	„ „
Springbok-fontein	2	29·40	17·53	3200	1882–84	„ „
Sutherland	2	32·25	20·40	4700	1879–84	„ „
Swellendam	2	34·4	20·27	500	1880–84	„ „
Umtata	2	31·45	29·0		1882–84	„ „
Wellington	2	33·38	19·0	400	1876–84	„ „
Wynberg	2	34·0	18·2	250	1876–84	„ „
WEST.						
Angra do Heroismo	2	38·39 N	27·14 W	144	1875–84	Ann. do Obs. do Infante D. Luiz.
Ascension	2	7·55 S	14·25 W	52	1863–65	Zeit. für Met. XIII. p. 410.
Bakel	2	14·53 N	12·29 W			
Chinchosho	2	5·9 S	12·35 E			
Christiansborg	2	5·36 N	0·10 W	66	1829–42	Quarterly Jour. II. p. 52.
Dagana	2	16·30 N	15·51 W			
Elmina	2	5·5 N	1·20 W	59	1860–62	Quarterly Jour. II. p. 52.
Fernando Po	2	3·46 N	8·36 E			
Freetown	2	8·29 N	13·9 W			
Funchal	2	32·38 N	16·55 W	82	1875–84	Ann. do Obs. do Infante D. Luiz.
Gaboon	2	0·25 N	9·35 E			
Great Bassam	2	5·11 N	3·30 W			
Lagos	2	6·12 N	3·25 W		1863	Proc. Brit. Met. Soc. II. p. 157.
Laguna	2	28·12 N	16·21 W	1660	1877–84	Resu. de las Obs. Met. de Provincias.
Las Palmas	2	27·28 N	15·28 W	30	1882–84	„ „
Malange	2	9·33 S	16·38 E			

XXIX. AFRICA (GENERAL)—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
WEST. (*Continued.*)		° ′	° ′	ft.		
Ponta Delgada	2	37·45 N	25·41 W	66	1876–84	Ann. do Obs. do Infante D. Luiz.
Praya	2	14·13 N	23·30 W			
ST. HELENA	1	15·57 S	5·41 W	1765	1840–49	Mag. and Met. Obsns. St. Helena.
St. Louis	2	16·1 N	18·31 W			
St. Nicolao	2	16·40 N	24·15 W			
ST. PAUL DE LOANDA	1	8·49 S	13·7 E	194	1879–84	Ann. do Obs. do Infante D. Luiz.
St. Salvador	2	6·17 S	14·53 E	1834		
St. Thomas	2	0·20 N	6·43 E	16	1879–84	Ann. do Obs. do Infante D. Luiz.
St. Vincent	2	25·4 N	16·54 W	36		
Teneriffe	2	28·12 N	16·21 W	1867	1869–73	Zeit. für Met. XII. p. 138.
CENTRAL.						
Gondokoro	2	4·55 N	31·28 E	1526		„ X. p. 187 & XVI. p. 352.
Khartoum	2	15·36 N	32·36 E	1273	1878	„ X. p. 187 & XVI. p. 352.
Lado	2	5·2 N	31·50 E	1526		„ XVI. p. 352.

XXX. ALGERIA.

Aflou	2	34·13	2·3 E	4429	1875–84	Ann. du Bureau Cent. Met. de France.
Algiers (Hôpital du Dey)	2	36·47	3·4 E	72	1865–84	
Algiers (F. l'Empereur)	2	36·47	3·4 E	732	1875–84	„ „
Aumale	2	36·10	3·41 E	2969	1874–84	„ „
Batna	2	35·22	6·10 E	3471	1875–84	„ „
Biskra	2	34·51	5·40 E	410	1874–84	„ „
Bosquet	2	36·5	0·20 E	1050	1880–84	„ „
Boufarik	2	36·35	2·55 E		1878–84	„ „
Bougie	2	36·47	5·5 E	220	1865–84	„ „
Bou-Saada	2	35·10	4·15 E	2139	1880–84	„ „
Cap Caxine	2	36·48	3·2 E	125	1874–84	„ „
Cap Falcon	2	35·46	0·47 W	256	1876–84	„ „
Cap de Garde	2	36·58	7·47 E		1875–84	„ „
Constantine	2	36·22	6·36 E	2165	1865–84	„ „
Djelfa	2	34·40	3·8 E	3829	1874–84	„ „
Djidjelli	2	36·50	5·43 E	43	1876–84	„ „
El Aricha	2	34·16	1·13 W	4101	1875–84	„ „
Fort National	2	36·38	4·12 E	3051	1871–84	„ „
Géryville	2	33·45	1·10 E	4285	1874–84	„ „
Guelma	2	36·28	7·27 E	915	1875–84	„ „
La Calle	2	36·54	8·26 E	36	1864–84	„ „
Laghouat	2	33·48	2·51 E	2526	1874–84	„ „
Mecheria	2	33·43	0·8 W	3740	1881–84	„ „
Médéah	2	36·16	2·45 E	3002	1874–84	„ „
Nemours	2	35·6	1·51 W	13	1875–84	„ „
Oran	2	35·42	0·39 W	174	1860–84	„ „
Orléansville	2	36·10	1·21 E	387	1875–84	„ „
Philippeville	2	36·53	6·54 E		1866–84	„ „
Saïda	2	34·51	0·10 E	2845	1874–84	„ „
Ste. Hélène	2				1875–84	„ „
Sétif	2	36·11	5·26 E	3563	1875–84	„ „
Sidi-Bel-Abbès	2	35·2	0·39 W	1562	1875–84	„ „
Staouéli	2	36·44	2·55 E	377	1874–84	„ „
Tébessa	2	35·24	8·6 E	2890	1875–84	„ „
Teniet-el-Had	2	35·53	2·1 E	3750	1875–84	„ „
Tiaret	2	35·23	1·18 E	3563	1879–84	„ „
Tizi Ouzon	2	36·22	4·3 E	768	1876–84	„ „
Tlemcen	2	34·53	1·18 W	2703	1875–84	„ „

AMERICA.

XXXI. UNITED STATES.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N ° ′	W ° ′	ft.		Report of Chief Signal Officer.
Albany	2	42·39	73·45	75	1830–84	„ „
Alexander Fort	2	58·57	158·18		1881–84	„ „
Alpena	2	45·05	83·30	609	1873–84	„ „
Apache, Fort	2	33·48	109·57	5050	1878–84	„ „
Assinnaboine, Ft.	2	48·32	109·42	2710	1880–84	„ „
Atlanta	2	33·45	84·23	1131	1879–84	„ „
Atlantic City	2	39·22	74·25	13	1874–84	„ „
Augusta	2	33·28	81·54	183	1834–84	„ „
Baltimore	2	39·18	76·37	45	1871–84	„ „
Barnegat City	2	39·46	74·06	20	1874–84	„ „
Behring Id.	2	55·12	*165·55	20		„ „
Bennett, Fort	2	44·43	100·39	1510	1880–84	„ „
Benton, Fort	2	47·50	110·40	2700	1880–84	„ „
Billings	2	45·49	108·30	3115?	1881–83	„ „
Bismarck	2	46·47	100·38	1694	1875–84	„ „
Block Id.	2	41·10	71·36	27		„ „
Boerne	2	29·48	98·39	1333	1876–80	„ „
Boise City	2	43·37	116·08	2750	1878–84	„ „
Boston	2	42·21	71·04	142	1871–84	„ „
Brackettville	2	29·17	100·51	1050	1879–81	„ „
Breckenbridge	2	46·11	96·17	966	1872–80	„ „
Brownsville	2	25·53	97·26	43	1876–84	„ „
Buffalo	2	42·53	78·53	696	1871–84	„ „
Buford, Fort	2	48·00	103·56	1900	1879–84	„ „
Burks	2	32·55	113·20		1878–80	„ „
Burlington	2	44·29	73·13	268	1871–83	„ „
Cairo	2	37·00	89·10	377	1871–84	„ „
Campo	2	32·37	116·25	2527	1875–82	„ „
Cape Hatteras	2	35·13	75·30	8	1875–80	„ „
Cape Henry	2	36·56	76·00	16	1874–84	„ „
Cape May	2	38·56	74·58	27	1871–84	„ „
Cape Lookout	2	34·36	76·36	15	1876–80	„ „
Cape Mendocino	2	40·26	124·24	637		„ „
Castroville	2	29·25	98·50	780	1872–82	„ „
Cedar Keys	2	29·08	83·02	22	1880–84	„ „
Champaign	2	40·8	88·14	767	1880–83	„ „
Charleston	2	32·47	79·56	52	1780–84	„ „
Charlotte	2	35·13	80·51	808	1879–84	„ „
Chattanooga	2	35·04	85·15	783	1879–84	„ „
Cheyenne	2	41·08	104·48	6089	1871–84	„ „
Chicago	2	41·52	87·38	661	1871–84	„ „
Chincoteague	2	37·55	75·23	18	1880–84	„ „
Cincinnati	2	39·06	84·30	620	1835–84	„ „
Cleveland	2	41·30	81·42	690	1871–84	„ „
Coleman City	2	31·53	99·18	1709	1878–83	„ „
Colorado Springs	2	38·55	104·58		1874–76	„ „
Columbus	2	39·58	83·00	805	1879–84	„ „
Concho, Fort	2	31·25	100·24	1900	1877–84	„ „
Corsicana	2	32·5	96·30	445	1874–81	„ „
Custer, Fort	2	45·48	107·38	3086	1879–84	„ „
Davenport	2	41·30	90·38	615	1871–84	„ „
Davis, Fort	2	30·38	103·56	4940	1878–84	„ „
Dayton	2	46·19	117·56	1660	1880–84	„ „

* E. Longitude.

XXXI. UNITED STATES—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	W			Report of Chief Signal Officer.
		° ′	° ′			
Deadwood	2	44·23	103·43	4600	1879–84	" "
Decatur	2	33·12	97·35	1150	1877–82	" "
Delaware Breakwater	2	38·48	75·10	20	1880–84	" "
Denison	2	33·48	96·32	767	1875–82	" "
Denver	2	39·45	105·00	5294	1872–84	" "
Des Moines	2	41·35	93·37	849	1879–84	" "
Detroit	2	42·20	83·03	661	1850–84	" "
Dodge City	2	37·45	100·00	2512	1875–84	" "
Dubuque	2	42·30	90·44	665	1874–84	" "
Duluth	2	46·48	92·06	644	1871–84	" "
Eagle Pass	2	28·44	100·29	780	1876–83	" "
Eagle Rock	2	43·32	111·55	4650	1881–83	" "
Eastport	2	44·54	66·59	61	1873–84	" "
Elliott, Fort	2	35·30	100·21	2650	1880–84	" "
El Paso	2	31·47	106·30	3760	1878–84	" "
Erie	2	42·07	80·05	681	1873–84	" "
Escanaba	2	45·48	87·05	612	1871–84	" "
Florence	2	33·3	111·19	1553	1875–81	" "
Fort Smith	2			470		" "
Fredericksburg	2	30·17	98·52	1700	1877–82	" "
Galveston	2	29·18	94·47	48	1871–84	" "
Gibson, Fort	2	35·50	95·20	540	1874–82	" "
Grand Haven	2	43·05	86·18	620	1871–84	" "
Grant, Fort	2	32·39	109·57	4856	1872–84	" "
Griffin, Fort	2	32·53	99·21	1290	1876–81	" "
Hatteras	2	35·15	75·40	19	1875–84	" "
Helena	2	46·34	112·04	4100	1880–84	" "
Henrietta	2	33·46	98·12	980	1878–82	" "
Huron	2	44·21	98·09	1305		" "
Indianapolis	2	39·46	86·10	753	1871–84	" "
Indianola	2	28·32	96·31	26	1872–84	" "
Jacksboro	2	33·12	98·10	1120	1877–83	" "
Jacksonville	2	30·20	81·39	43	1872–84	" "
Keogh, Fort	2	46·22	105·56	2372	1879–83	" "
Keokuk	2	40·22	91·26	618	1872–84	" "
Key West	2	24·34	81·49	20	1841–84	" "
Kittyhawk	2	36·00	75·42	22	1875–84	" "
Knoxville	2	35·56	83·58	980	1871–84	" "
La Crosse	2	43·49	91·15	725	1873–84	" "
Lady Franklin Bay	2	81·40	64·30		1881–83	" "
Lamar	2			1028		" "
La Mesilla	2	32·17	106·48	4124	1877–82	" "
Lareodo	2	27·32	99·30	401	1878–81	" "
Leavenworth	2	39·19	94·57	842	1835–84	" "
Lewiston	2	46·28	117·05	780	1880–84	" "
Little Rock	2	34·45	92·06	298	1880–84	" "
Los Angeles	2	34·03	118·15	371	1878–84	" "
Louisville	2	38·15	85·45	530	1872–84	" "
Lynchburg	2	37·25	79·09	652	1871–84	" "
Mackinaw City	2	45·47	84·39	605		" "
Macon, Fort	2	34·42	76·40	11	1869–84	" "
Madison	2	43·3	89·24	949	1878–82	" "
Maginnis Fort	2	47·12	109·10	4340		" "
McKavett, Fort	2	30·48	100·07	2240	1876–82	" "
Marquette	2	46·34	87·24	673	1871–84	" "
Memphis	2	35·09	90·03	321	1871–84	" "
Milwaukee	2	43·02	87·54	697	1870–84	" "
Missoula, Fort	2	46·50	114·07	3140	1880–83	" "
Mobile	2	30·41	88·02	41	1871–84	" "

XXXI. UNITED STATES—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N ° ′	W ° ′	ft.		Report of Chief Signal Officer.
Montgomery	2	32·23	86·18	219	1873–84	„ „
Moorhead	2	46·52	96·44	923		„ „
Morgantown	2	39·40	79·50	963	1873–82	„ „
Mt. Washington	2	44·16	71·18	6279	1871–84	„ „
Nashville	2	36·10	86·47	507	1871–84	„ „
New Haven	2	41·18	72·56	107	1799–84	„ „
New London	2	41·21	72·05	47	1871–84	„ „
New Orleans	2	29·58	90·04	52	1834–84	„ „
Newport	2	41·29	71·19	44	1876–82	„ „
New York	2	40·43	74·00	164	1871–84	„ „
Norfolk	2	36·51	76·17	30	1871–84	„ „
North Platte	2	41·08	100·45	2841	1875–84	„ „
Olympia	2	47·03	122·53	36	1878–84	„ „
Omaha	2	41·16	95·56	1113	1871–84	„ „
Ooglaamie	2	71·17	156·40	17	1881–83	„ „
Oswego	2	43·29	76·35	304	1871–84	„ „
Palestine	2	31·45	95·40	523		„ „
Pembina	2	49·0	97·5	791	1872–80	„ „
Pensacola	2	30·25	87·13	30	1880–84	„ „
Philadelphia	2	39·57	75·09	92	1772–84	„ „
Phœnix	2	33·28	112·0	1068	1877–81	„ „
Pike's Peak	2	38·50	105·02	14134	1874–84	„ „
Pilot Point	2	33·20	96·50	800	1877–80	„ „
Pioche	2	37·56	114·26	6110	1878–83	„ „
Pittsburg	2	40·32	80·02	762	1880–84	„ „
Poplar River	2	48·08	105·10	2030		„ „
Port Angeles	2			14		„ „
Port Eads	2	29·09	89·15	7		„ „
Port Huron	2	43·00	82·26	633	1875–84	„ „
Portland, Maine	2	43·39	70·15	45	1826–84	„ „
Portland, Oregon	2	45·32	122·43	67	1872–84	„ „
Portsmouth	2	35·02	76·04	40	1876–83	„ „
Prescott	2	34·33	112·28	5340	1876–84	„ „
Provincetown	2	42·03	70·11	26	1880–84	„ „
Punta Rassa	2	26·29	82·01	13	1872–83	„ „
Red Bluff	2	40·10	122·15	350	1878–84	„ „
Rio Grande City	2	26·22	98·48	230	1876–84	„ „
Rochester	2	43·08	77·42	621	1871–84	„ „
Roseburg	2	43·13	123·20	511	1878–84	„ „
Sacramento	2	38·35	121·30	65	1868–84	„ „
Saint Louis	2	38·38	90·12	568	1835–84	„ „
Saint Michael, Fort	2	63·48	162·00	30	1874–84	„ „
Saint Paul	2	44·58	93·03	811	1871–84	„ „
Saint Paul, Alaska	2	57·47	152·21	54	1870–84	Pacific Coast Pilot.
Saint Paul's Island	2	57·38	169·50		1873–82	„ „
Saint Vincent	2	48·56	97·14	804		Rep. Chief Sig. Officer.
Salt Lake City	2	40·46	111·54	4348	1874–84	„ „
San Antonio	2	29·25	98·25	673	1877–84	„ „
San Diego	2	32·43	117·10	67	1872–84	„ „
Sandusky	2	41·25	82·40	639	1878–84	„ „
Sandy Hook	2	40·28	74·00	28	1874–84	„ „
Sanford	2	43·05	89·24	949		„ „
San Francisco	2	37·48	122·26	60	1871–84	„ „
Santa Fé	2	35·41	105·57	7106	1860–84	„ „
Savannah	2	32·05	81·05	87	1848–84	„ „
Shaw, Fort	2	47·31	111·48	3550	1880–84	„ „
Shreveport	2	32·30	93·40	227	1872–84	„ „
Sill, Fort	2	34·40	98·23	1200	1876–84	„ „
Silver City	2	32·48	108·16	5796	1878–82	„ „

XXXI. UNITED STATES—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	W			
		° ′	° ′	ft.		
Sitka	2	57·03	135·19	63	1828–84, irreg.	Pacific Coast Pilot.
Smith, Fort	2	35·22	94·24	449	1863–84	Rep. Chief Sig. Officer.
Smithville	2	33·55	78·01	34	1876–84	" "
Sorocco	2	34·5	106·55	4565	1877–80	" "
Spokane Falls	2	47·40	117·25	1910?		" "
Springfield, Ill.	2	39·48	89·39	644	1880–84	" "
Springfield, Ma.	2	37·12	93·18	1351	1874–82	" "
Starkville	2	33·35	88·49	455	1881–83	" "
Stevenson, Fort	2	47·35	101·28	1750	1879–83	" "
Stockton, Fort	2	30·53	102·53	3010	1870–84	" "
Sully, Fort	2	44·39	100·36		1871–77	" "
Thatcher's Island	2	42·38	70·34	48	1876–83	" "
Thomas, Camp	2	33·04	110·02	2710	1880–84	" "
Toledo	2	41·40	83·34	651	1871–84	" "
Tucson	2	32·14	110·53	2369	1876–83	" "
Umatilla	2	45·55	119·21	184	1877–82	" "
Unalashka	2	53·53	166·32	13	1879–84	" "
Uvalde	2	29·13	99·40	891	1876–82	" "
Verde, Fort	2	34·33	111·52	3105	1876–83	" "
Vicksburg	2	32·22	90·53	244	1872–84	" "
Virginia City	2	45·20	112·3	5810	1871–80	" "
Visalia	2	36·20	119·17	348	1878–83	" "
Washakie, Fort	2	42·59	108·43	5580	1881–83	" "
Washington, D. C.	2	38·54	77·02	106	1836–84	" "
W. Las Animas	2	38·04	103·07	3905		" "
Wickenburg	2	33·58	112·42	1400	1875–81	" "
Williamsport	2	41·15	77·03	561	1881–83	" "
Wilmington	2	34·14	77·57	52	1871–84	" "
Winnemucca	2	40·59	117·43	4327	1878–84	" "
Wood's Holl	2	41·33	70·40	34	1873–81	" "
Yankton	2	42·54	97·28	1228	1873–84	" "
Yuma	2	32·45	114·36	141	1876–84	" "

XXXII. DOMINION OF CANADA.

BRITISH COLUMBIA.						
Victoria	2	48·25	123·22	50		Report of Met. Off. of Canada.
WESTMINSTER	1	49·12	122·53			
HUDSON'S BAY.						
Fort Albany	2	52·12	82·5			" "
Martens Falls	2	51·30	86·30			" "
Moose Fort	2	51·16	82·56			" "
York Factory	2	57·0	92·26	55	1876–84	" "
MANITOBA AND NORTH-WEST TERRITORY.						
Battleford	2	52·41	108·30			" "
Blair	2	49·40	100·40			" "
Edmonton	2	53·14	113·38	2380		" "
Fort Calgary	2	50·55	113·45	3389		" "
Fort Chipewyan	2	58·38	111·20			" "
Humbolt	2	52·12	105·10			" "
Medicine Hat	2	50·0	110·40	2136		" "
Minnedosa	2	50·14	99·47	1766		" "

XXXII. DOMINION OF CANADA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
MANITOBA AND NORTH-WEST TERRITORY. (*Continued.*)		N ° ′	W ° ′	ft.		
Oak Lake	2	49·45	100·35			Report of Met. Off. of Canada.
Poplar Heights	2	50·4	97·47			" "
Prince Albert	2	53·10	106·10			" "
Qu' Appelle	2	50·33	103·53	2115		" "
Rapid City	2	50·7	100·0			" "
St. Andrew's	2	50·5	97·0			" "
Stony Mountain	2	50·5	97·12			" "
WINNIPEG	1	49·55	97·7	754		" "
NEW BRUNSWICK.						
Bathurst	2	47·39	65·42	35		" "
Chatham	2	47·3	65·29	56		" "
Dalhousie	2	48·4	66·22	45		" "
FREDERICTON	1	45·57	66·38	59		" "
Grand Manan	2	44·42	66·48	48		" "
St. Andrew's	2	45·5	67·4	47		" "
ST. JOHN	1	45·17	66·3	116		" "
NEWFOUNDLAND.						
Channel	2	47·34	59·7	30		" "
Notre Dame Bay	2	50·0	57·0			" "
St. John's	2	47·34	52·42	230		" "
St. Pierre	2	46·47	56·12			" "
NOVA SCOTIA.						
Baddeck	2	46·6	60·49	25		" "
HALIFAX	1	44·39	63·36	122		" "
Little Glace Bay	2	46·12	59·58	34		" "
Pictou	2	45·42	62·41			" "
SYDNEY	1	46·8	60·10	37		" "
Truro	2	45·22	63·18	40		" "
Windsor	2	44·59	64·6	87		" "
Yarmouth	2	43·50	66·2	86		" "
ONTARIO.						
Barrie	2	44·23	79·40	779		" "
Conestogo	2	43·23	80·31			" "
Cornwall	2	45·1	74·43	175		" "
Deseronto	2	44·11	77·4	272		" "
Durham	2	44·10	80·50	1450		" "
Fitzroy Harbour	2	45·30	76·14			" "
Goderich	2	43·45	81·43	728		" "
Granton	2	43·12	81·21	1015		" "
Guelph	2	43·33	80·16	1161		" "
Hamilton	2	43·16	79·53	350		" "
Huntsville	2	45·30	79·8			" "
Kincardine	2	44·11	81·37	684		" "
KINGSTON	1	44·14	76·29	307		" "
Lindsay	2	44·20	78·45	876		" "
London	2	43·0	81·15	816		" "
Mamainse	2	47·30	84·50			" "
Mount Forest	2	43·58	80·44	1376		" "
Ottawa	2	45·26	75·41	223		" "
Parry Sound	2	45·19	80·0	635		" "
Pembroke	2	45·50	77·7	423		" "

XXXII. DOMINION OF CANADA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
ONTARIO. (*Continued.*)		N. ° ′	W. ° ′			
Penetanguishene	2	44·45	79·56			Report of Met. Off. of Canada.
Peterborough	2	44·17	78·18	675		
Port Dover	2	42·47	80·13	635		" "
Port Stanley	2	42·40	81·13	592		" "
Prince Arthur's Landing	2	48·27	89·12	642		" "
Rockliffe	2	46·12	77·55	414		" "
Saugeen	2	44·30	81·21	656		" "
Simcoe	2	42·50	80·21	724		" "
Stratford	2	43·23	81·0	1182		" "
Strathroy	2	42·56	81·42			" "
TORONTO	1	43·39	79·23	350	1841–84	" "
Windsor	2	42·19	83·2	620		" "
WOODSTOCK	1	43·8	80·47	980		" "
PRINCE EDWARD'S ISLAND.						
Charlottetown	2	46·14	63·10	38		" "
Kilmuhumay	2	46·48	64·2	20		" "
QUEBEC.						
Anticosti	2	49·24	63·36	30		" "
Bird Rock	2	47·51	61·8	106		" "
Chicoutimi	2	48·25	71·5	150		" "
Cranbourne	2	46·22	70·37			" "
Father Point	2	48·31	68·28	20		" "
Huntingdon	2	45·5	74·10			" "
MONTREAL	1	45·30	73·35	187		" "
QUEBEC	1	46·48	71·12	293		" "
Richmond	2	45·40	72·8	437		" "
WEST INDIES.						
Bermuda	2	32·17	64·47	151	1866–84	Army Med. Dep. Report.

XXXIII. CENTRAL AMERICA AND MEXICO.

Acapantzingo						Bol. del Ministero de Fomento de la Repub. Mex.
Belize	2	17·30	88·18		1865–69	Zeit. für Met. VII. p. 160.
Campeche	2	19·51	90·33	28		Bol. del Ministero de Fomento de la Repub. Mex.
Cuernavaca	2	18·55	90·0	4938	1873–74	Zeit. für. Met. XIV. p. 25.
Guadalajara	2	21·5	103·0	5092	1877–84	Bol. del Ministero de Fomento de la Repub. Mex.
Guanajuato	2	21·7	101·17	6761	1877–84	" "
Heredia	2	9·59	84·9			
Huejutla	2	21·41	107·24	1234		Bol. del Ministero de Fomento de la Repub. Mex.
Leon de Aldamas	2	21·7	101·43	5901	1877–84	" "
Mazatlan	2	23·11	106·24	249		" "
MEXICO	1	19·26	99·7	7489	1877–84	" "
Morelia	2	19·42	101·6	6365	1877–84	" "
Pabellon	2	22·4	102·11	6314	1877–84	" "
Puebla	2	19·3	98·12	7125	1877–84	" "
Querétaro	2	20·26	100·23	6070	1877–84	" "
Rivas	2	11·26	85·47	150		Rep. of Chief Signal Officer.
San José	2	9·56	84·0	3757	1868–78	Zeit. für Met. XIV. p. 450.
San Luis Potosi	2	22·9	101·12	6202	1877–84	Bol. del Ministero de Fomento de la Repub. Mex.
Veracruz	2	21·53	102·14	6106	1877–84	" "
Zacatecas	2	22·50	102·10	8189	1877–84	" "

XXXIII. CENTRAL AMERICA AND MEXICO—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		N	W			
		° ′	° ′	ft.		
West Indies.						
Kingston	2	17·58	76·48	10	1880–84	Rep. of Chief Signal Officer.
St. Thomas...............	2	18·20	64·56	131	1880–84	Meteorologisk Aarbog.
Santa Cruz...............	2	17·45	64·42	7	1875–84	„ „
Santiago de Cuba	2	19·55	75·50	21	1880–84	Rep. of Chief Signal Officer.

XXXIV. SOUTH AMERICA.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		S	W			
Ancud	2	41·46	74·1	174	1870–72	Zeit. für Met. XII. p. 359.
Antisana..................	2	0·21	78·6	13320	1845–46	„ XIV. p. 218.
Arica	2	18·25	70·22		1854–55	„ IX. p. 59.
Asuncion	2	25·16	57·40	1634		„ XI. p. 332.
Ayachucho					1881	An. de Oficina. Met. Argent.
Bahia Blanca............	2	38·43	62·20	63	1860–83	„ „
Bogota	2	4·36 N	74·14	8655		Rep. of Chief Signal Officer
Buenos Ayres............	2	34·36	58·21	102		An. de Oficina Met. Argent.
Caldera	2	27·3	70·50	82	1869–70	Zeit. für. Met. VIII. p. 153 and XII. p. 359.
Caracas	2	10·30 N	66·5	3041	1868–70	Zeit. für Met. VII. p. 380.
Catamarca	2					An. de Oficina Met. Argent.
Chacra de Matanzas...					1881	„ „
Chubut	2	43·20	65·10	98	1880–82	„ „
Cilecito						„ „
Conception	2	36·49	73·1	0	1869	Zeit. für. Met. VIII. p. 153, and XII. p. 359.
Concordia	2	21·25	58·5		1876–78	Zeit. für. Met. XV. p. 370.
Constitucion	2	35·20	72·28		1870–72	„ „
Copiapo	2	27·22	70·23	1296	1864–72	„ VI. p. 27, VIII. p. 153.
Coquimbo	2	29·56	71·21	82	1869–72	„ VIII. p. 153. XII. p. 359.
Cordoba		31·0	65·0			An. de Oficina. Met. Argent.
Corral	2	39·52	73·17	105	1870–72	
Corrientes					1881	An. de Oficina. Met. Argent.
Curuzu-Cuatia						„ „ „
Dolores	2	36·19	58·20	33	1878–82	„ „ „
Georgetown	2	6·50 N	58·8	10		Zeit. für. Met. XVIII. p. 102.
Goya						An. de Oficina Met. Argent.
Guatemala		14·38 N	90·31	4856	1880–82	Zeit. fur. Met. XIX. p. 137.
Joinville	2	26·19	53·48		1867	„ „ XIII. p. 79.
Lima	2	12·3	79·29	499	1869	„ „ VI. p. 176.
Manaos	2	3·8	60·0	121		„ „ VIII. p. 267.
Melipulli	2	41·30	72·47	0	1869	„ „ VIII. p. 153.
Mendoza	2	32·51	67·32	2559	1852 and 1857	„ „ VI. p. 139.
Montevideo	2	34·54	56·13	26	1843–52	„ „ VI. p. 138.
Orange Bay		53·31		39	1882–83	Compt. Rend. XCVIII. p. 25.
Palmeira	2	27·54	53·26	1896	1879–80	Zeit. für. Met. XV. p. 407, XVI. p. 202.
Paramaribo	2	5·50 N	55·13	6		Rep. of Chief Sig. Officer.
Parana	2	31·44	60·33	255	1875–82	An. de Oficiua Met. Argent.
Passo Fundo	2	28·13	52·12	2060	1880–81	Zeit. für Met. XV. p. 348, and XVIII. p. 301.
Pelotas	2	31·47	52·19	54	1875–82	Zeit. für Met. XV. p. 328, and XIX. p. 410.
Pernambuco	2	8·4	34·52	12		„ „ XIV. p. 213.
Pilciao	2	27·32	67·9		1874	„ „ XV. p. 348.
Porto Alegre	2	30·6	51·49			
Puerto Berrio	2	6·22	74·28	542		Rep. of Chief Sig. Officer.

XXXIV. SOUTH AMERICA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
		S	W			
		° ′	° ′	ft.		
Puerto Monte	2	41·30	72·52	33	1857–72, irreg.	Zeit. für Met. V. p. 399.
Punta Arenas	2	53·12	70·56	33	1853–63, 1871–2	„ V. p. 369.
Quito	2	0·14	78·45	9350	1878–79	„ XVI. p. 479.
Rio de Janeiro		22·54	43·20	209		
Rio Cuarto	2	33·7	64·19	204	1881–82	An. de Oficina Met. Argent.
Rioja	2	29·20	67·15	1772	1875–81	„ „ „
Rosario	2	32·57	60·38	127	1875–80	„ „ „
St. Antonio de Areco	2	34·12	59·30	141	1879–81	„ „ „
S. Bento das Lages	2	12·37	38·40	98	1872–81	Zeit. für. Met. XVII. p. 401.
Salado	2	35·44	59·5	49	1878–82	An. de Oficina Met. Argent.
Salladillo	2			2654	1879–81	„ „ „
Salta	2	24·32	66·14		1873–74	„ „ „
San Juan	2					„ „ „
San Jorge	2	32·45	56·10		1867–68	Jour.Scot.Met.Soc. V.p. 329
Santa Cruz	2	29·35	52·30			Zeit. für Met. XI. p. 41.
Santiago	2	33·26	70·37	1867	1860–72	„ V. p. 441, VIII.p.156.
Santiago del Estero						An. de Oficina Met. Argent.
Serena	2	29·55	71·17	59	1849–50, 69–72	Zeit. für Met. VI. p. 26.
Stanley (Falkland Is.)	2	51·41	57·51		1875–77	Q. Journ. Roy. Met. Soc. VI. p. 199.
Talca	2	35·26	71·46	344	1869–72	Zeit. für Met. VIII. p. 153, XII. p. 359.
Tandil	2	37·17	59·8	651	1876–81	An. de Oficina Met Argent.
Taquara	2	29·40	50·47		1870–71	Zeit. für Met. VII, p. 228.
Tatay	2	34·16	60·0		1876–81	An. de Oficina Met. Argent.
Tucuman	2	26·50	66·2			„ „ „
Ushuaia(Tier.d.Fuego)	2	54·53	68·10		1882–83	„ „ „
Valdivia	2	39·49	73·13	43	1853–64, 69–72	Zeit. für Met. V. p. 399.
Valparaiso	2	33·2	71·40	36	1863–64, 66–72	„ V. p. 444, VIII.p.153.
Villa Formosa	2	26·13	58·10	328	1879–82	An. de Oficina. Met. Argent.
Villa Hernandarias	2	31·10	60·0	190	1877–81	„ „ „

AUSTRALASIA.

XXXV. AUSTRALIA.

New South Wales.			E			
Albury	2	36·6	147·0	572	1860–84, irreg.	Results of Met. Obs. made in N. S. W.
Armidale	2	30·34	151·46	3278	1858–84, irreg.	
Bathurst	2	33·24	149·37	2200	1858–84	„ „
Bourke	2	30·3	145·58	456	1876–84	„ „
Cape St. George	2	35·12	150·45	175	1867–84	„ „
Clarence River Heads	2	29·28	153·21	120	1877–84	„ „
Cobar	2	31·32	145·50			„ „
Cooma	2	36·12	149·9	2637	1858–84	„ „
Coonabarabran	2	31·16	149·18			„ „
Deniliquin	2	35·32	145·2	320	1858–84, irreg.	„ „
Eden	2	37·0	149·59	107	1869–84	„ „
Forbes	2	33·27	148·5	1120	1873–84	„ „
Goulburn	2	34·45	149·45	2129	1858–65, 70–84	„ „
Gurmedah	2	31·1	150·15	925	1877–84	„ „
Hay	2	34·30	144·56			„ „
Inverell	2	29·48	151·10	1953	1874–84	„ „
Kiandra	2	35·52	148·32	4640	1867–84	„ „
Menindee	2	32·23	142·26			„ „
Milton	2	35·14	150·20			„ „
Moruya	2	35·53	150·6	50	1877–84	„ „

XXXV. AUSTRALIA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
NEW SOUTH WALES. (*Continued.*)		S ° ′	E ° ′	ft.		
Mount Victoria	2	33·36	150·15	3490	1872–84	Resuts of Met. Obs. made in N. S. W.
Newcastle	2	32·55	151·50	112	1862–84	
Port Macquarie	2	31·25	152·54	53	1873–84	" "
SYDNEY	1	33·51	151·12	155	1858–84	" "
Tamworth	2	31·7	150·55	1271	1876–84	" "
Wagga Wagga	2	35·8	147·24	793	1872–84	" "
Walgett	2	30·2	148·0			" "
Wentworth	2	34·8	142·0	144	1877–84	" "
Wollongong	2	34·25	150·56	67	1877–84	" "
QUEENSLAND.						
Brisbane	2	27·27	153·3	110	1872–84	Ann. Report of Registrar General.
Cape Moreton	2	27·2	153·29	320	1873–84	
Cooktown	2	15·27	145·15	20	1880–84	" "
Good Island (Torres Straits)	2	10·33	142·10	300	1880–84	" "
Rockhampton	2	20·25	150·25	50	1879–84	" "
Toowoomba	2	27·34	152·10	1960	1872–84	" "
Townsville	2	19·18	146·50	20	1879–84	" "
Warwick	2	28·12	152·16	1520	1877–84	" "
SOUTH AUSTRALIA.						
Adelaide	2	34·57	138·35	140	1857–84	Met. Obs. made at Adelaide and in S. Australia.
Alice Springs	2	23·41	133·37	2100		
Cape Borda	2	35·45	136·35	506		" "
Cape Northumberland	2	38·5	140·40	117		" "
Daly Waters	2	16·18	133·25	750		" "
Eucla	2	31·45	128·58	7		" "
Kapunda	2	34·22	138·57	800		" "
Mount Gambier	2	37·50	140·50	130	1861–84	" "
Port Augusta	2	32·30	137·45	10	1861–84	" "
Port Darwin	2	12·28	130·51	70		" "
Robe	2	37·10	139·42	19		" "
Strathalbyn	2	35·16	138·55	220	1861–84	" "
Streaky Bay	2	32·50	134·12	40		" "
TASMANIA.						
Circular Head	2	40·43	145·17	64		Proc. of the Roy. Soc. of Tasmania.
Falmouth	2	41·32	148·19	30		
Hobart	2	42·53	147·20	190	1844–84	" "
Launceston	2	41·26	147·10	76		" "
Low Head	2	41·3	146·48	25		" "
Oatlands	2	41·32	147·24	1340		" "
Southport	2	43·26	147·1	50		" "
VICTORIA.						
Ararat	2	37·18	142·58	1050		Results of Obs. in Met., Terr. Magnet, &c.
Ballarat	2	37·34	143·49	1438	1858–84	
Cape Otway	2	38·54	143·31	270	1862–84	" "
Cape Schanck	2	38·28	144·53	277		" "
Echuca	2	36·7	144·48	314		" "
Gabo Island	2	37·35	149·55	50	1862–84	" "
Lakes Entrance	2	37·52	148·1			" "
Melbourne	2	37·50	144·59	91	1858–84	" "
Omeo	2	37·6	147·36	2108		" "
Port Albert	2	38·39	146·41	10	1862–84	" "

XXXV. AUSTRALIA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
VICTORIA. (*Continued.*)		S ° '	E ° '	ft.		
Portland	2	38·20	141·35	37	1862–84	Results of Obs. in Met., Terr. Magent, &c.
Sandhurst	2	36·47	144·17	758	1860–84	
Upper Macedon	2	37·23	144·35	3000		„ „
Wilson's Promontory	2	39·8	146·26	300	1876–84	„ „
WEST AUSTRALIA.						
Albany	2	35·2	117·54	88	1879–84	W. Australia Met. Rep.
Bunbury	2	33·18	115·38	18	1879–84	„ „
Cossack	2	20·40	117·8	19	1881–84	„ „
Fremantle	2	32·3	115·45	40	1879–84	„ „
Geraldton	2	28·47	114·36	5	1879–84	„ „
Perth	2	31·57	115·52	47	1876–84	„ „
Rottnest	2	31·49	115·33	47	1879–84	„ „
York	2	31·53	116·47	580	1879–84	„ „

XXXVI. NEW ZEALAND.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
Auckland	2	36·50	174·50	258	1855–84	Statistics of the Colony of New Zealand.
Bealey	2	43·2	171·31	2104	1867–80	
Cape Campbell	2	41·43	174·18	7	1874–80	„ „
Christchurch	2	43·32	172·39	21	1852–84, irreg.	„ „
Dunedin	2	45·52	170·31	550	1853–84	„ „
Hokitika	2	42·41	170·59	12	1866–80	„ „
Mongonui	2	35·1	173·28	70	1864–80	„ „
Napier	2	39·29	176·55	14	1864, 1866–80	„ „
Nelson	2	41·16	173·18	34	1844–54, 62–80	„ „
Queenstown	2	45·2	168·39	1070	1872–80	„ „
Southland	2	46·17	168·20	79	1859–80	„ „
Taranaki	2	39·3	174·5	42	1860–80	„ „
Waitangi (Chatham Island	2	43·52	W. 176·42 E	100	1879–80	„ „
Wanganui	2	39·56	175·6	80	1872–80	„ „
Wellington	2	41·16	174·47	140	1848–84, irreg.	„ „

XXXVII. OCEANIA.

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
BATAVIA	1	6·11 S	106·50 E	26	1866–84	Mag. & Met. Obs. Batav.
Buitenzorg	2	6·37 S	106·48 E	915	1841–54	Zeit. für Met. VIII. p. 55.
Cape York	2	10·44 S	142·36 E	69	1865–67	„ VI. p. 379.
Delanasau, Fiji	2	16·38 S	178·37 E	77	1871–84	Quar. Jour. Roy. Met. Soc.
Goose Island	2	40·18 S	147·45 E	26	1871–75	Results of Met. Obs. Hobartown.
Honolulu	2	21·16 N	157·52 W		1836–39	Zeit. für Met. VIII. p. 69.
Kent's Group	2	39·29 S	147·15 E	280	1871–75	Results of Met. Obs. Hobartown
King's Island	2	39·35 S	144·5 E	135	1871–75	„
Lahainaluna (Maui)	2	20·52 N	156·40 W	653	1844–45	Zeit. für Met. VIII. p. 69.
Manilla	2	14·35 N	120·59 E	108	1879–82	„ XV. p. 229 & XIX. p. 136.
Mount Nelson	2	43·0 S	147·0 E	1191	1871–75	Results of Met. Obs. Hobartown

XXXVII. OCEANIA—*Continued.*

Station.	Order.	Lat.	Long.	Altitude.	Years' Observations.	Where Published.
ICELAND. (*Continued.*)		° ′	° ′	ft.		
New Caledonia	2	22·20 S	166·39 E		1863–64	Zeit für Met. IV. p. 461.
Oparo (Rapa)............	2	27·26 S	144·11 W		1867–69	Quar. Jour. Roy. Met. Soc. III. p. 448.
Padang	2	0·56 S	100·2 E	16	1850–56	Zeit. für Met. VIII. p. 55.
Port Arthur	2	43·9 S	147·54 E	55	1871–75	Results of Met. Obs. Hobartown.
Samoa.....................	2	13·50 S	171·44 W		1862–64	Quar. Jour. Roy. Met. Soc. V. p. 178.
South Bruni	2	43·30 S	147·10 E	250	1871–75	Results of Met. Obs. Hobartown.
Swan Island	2	40·44 S	148·10 E	104	1871–75	
Tahiti (Papeeti).........	2	17·32 S	149·34 W		1847–49	Zeit. für Met. IV. p. 528.
Waioli.....................	2	22·15 N	159·30 W		1845–46	„ VIII. p. 69.
FAROE ISLANDS.						
Thorshavn	2	62·2 N	6·44 W	30	1873–84	Meteorologisk Aarbog.
GREENLAND.						
Godthaab	2	64·11	51·46	37	1861–84	„ „
Ivigtut.....................	2	61·12	48·11	16	1867–84	„ „
Jacobshavn	2	69·13	50·55	41	1866–84	„ „
Upernavik	2	72·47	55·53	39	1874–84	„ „
ICELAND.						
Berufjord	2	64·40	14·15	59	1873–84	„ „
Grunsey	2	66·34	18·3	59	1873–84	„ „
Stykkisholm	2	65·5	22·46	37	1857–84	„ „
Vestmanö	2	63·26	20·18	26	1877–84	„ „

ON THE MEASUREMENT OF SUNSHINE. By ROBERT H. SCOTT, M.A., F.R.S., President.

[Read March 18th, 1885.]

THE earliest mode of gauging the action of the sun was by attempting to measure the heat of Radiation, or, as it is generally termed abroad, of Insolation.

More than thirty years ago Pouillet proposed his Pyrheliometer for the purpose, and of this there were two kinds—the Pyrheliometer *direct* and the Pyrheliometer *à lentille*, which are described in his *Elements de Physique*. The former consisted of a shallow dish on a stand, containing about 100 grms. of water, and furnished with a thermometer in a reversed position, the bulb being immersed in the water, and also with an apparatus

for agitating the water thoroughly. A screen for cutting off the sun's rays is also provided. The apparatus is taken into the open air in the shade, and its rate of cooling or heating per minute noted. It is then placed in the sun, and the screen being withdrawn, its rate of heating per minute is observed for five minutes. It is finally taken back to the shade, and its rate of cooling noted. From these data the solar heat action is determined (*Tyndall, Heat as a Mode of Motion*, p. 416).

The Pyrheliometer *à lentille* is constructed so that the rays of the sun pass through a lens, and at the proper focal distance are received on the curved side of a vessel containing water; the surface of this vessel is always normal to the incident beam, whatever be the altitude of the sun. The actual experiment is made as before.

Sir John Herschel's Actinometer consists of a large cylindrical thermometer bulb, with a scale considerably expanded. The bulb is filled with a highly coloured liquid, usually the ammoniacal sulphate of copper. To take an observation, the actinometer is placed in the shade for a minute and then read: it is then exposed for one minute to the sun, and read: it is finally returned to the shade and read a third time. The mean of the two shade readings subtracted from that in the sun gives the expansion of the liquid for one minute in sunshine.

Hodgkinson's Actinometer[1] is on a principle similar to Herschel's.

These instruments have never come into very general use, and have been practically superseded by various adaptations of the thermometer with black bulbs, and placed in blackened boxes; finally culminating in the Black Bulb Thermometer *in vacuo*. This was proposed by Sir John Herschel, and has been very generally used, but it cannot be said to have given satisfaction, and the remarks which fell from Mr. Whipple at our last meeting[2] were far from encouraging as to the prospects of our obtaining a trustworthy instrument at a moderate cost. In the Exhibition this evening we have a thermometer with an error of 20°, apparently due to the use of cork supports to hold the thermometer tube inside the jacket. We must, however, await the results of the researches of Mr. de la Rue and Prof. W. G. Adams before we can absolutely condemn all existing instruments of this type.

We have specimens of black bulbs *in vacuo*, and of bright bulbs also *in vacuo*, the pair forming the arrangement favoured by M. Marié Davy.

There is a serious difference of opinion as to whether the amount of solar radiation is to be taken as the difference between the black bulb reading and the maximum, in the shade, for the day; in which case we have no certainty that the two phenomena are simultaneous; or, secondly, whether we should compare the black and bright bulbs, and take their difference of reading to represent the amount sought. This latter is Marié Davy's method, and his thermometers are ordinary, not maximum, instruments.

Of other instruments for measuring solar radiation, we have Stanley's thermometers, enclosed in hollow copper spheres with oxidised surface, which

[1] *Proceedings of the Royal Society*, XV. p. 321.
[2] *Quarterly Journal*, p. 127.

were described at the last Meeting of the Society,[1] and various other forms which have not yet come into general use.

Among these we have, taking them in the order of seniority, Secchi's apparatus. This consists of a double hollow cylinder. The space between the two cylinders is filled with a liquid, water or oil, at any convenient temperature. One thermometer passes through the two coatings, and has its bulb in the hollow core of the cylinder. Other similar thermometers pass into the liquid and serve to indicate its temperature. The rays of the sun pass along the axis and strike the thermometer.

In Prof. Balfour Stewart's actinometer the thermometer which is destined to indicate the heat of the sun is placed in a cavity in a cubical block of cast iron, and an aperture is made in the block to admit the solar rays when concentrated by a lens.

Frankland's resembles a Leslie's Differential Air Thermometer, one bulb being blackened and *in vacuo*, the other bright and sheltered by an arch of sheet zinc painted white. Mercury is introduced into the connecting tube, and its position under the action of insolation read on a scale.

Winstanley's Radiograph is also an adaptation of Leslie's instrument: in it the connecting tube is made to take a circular form, and the instrument is then suspended on a horizontal axis. The motion of the mercurial index, right or left, makes the instrument turn on its axis and so gives power to to trace a line on a recording drum.

The next series of instruments are those measuring the solar radiation of light. The oldest of those here to-night is Roscoe's first pattern (described in the *Philosophical Transactions*, 1865), in which the chemical action of total daylight, not of the sun only, is measured by the discolouration of sensitised paper. The instrument has been subsequently improved by Captain Abney, but has not come into general use.

Two instruments appear for measuring the duration of sunlight—M'Leod's and Jordan's; both of these act photographically, by using sensitised paper which is fixed by simple immersion in water. Mr. Jordan's is a marvel of simplicity of arrangement at least.

Lastly, we come to the registration of solar action by its effects in charring organic substances, such as wood, cloth or paper. The idea of such an instrument is due to the late Mr. J. F. Campbell of Islay, F.G.S., who devised it more than thirty years ago. The same gentleman also struck out the ingenious notion of employing a sphere as a lens, and so avoiding the necessity of a clock-work arrangement to drive the paper, if the rays were transmitted in a definite direction by a heliostat. Mr. Campbell describes the instrument in the *Report of the Council* of this Society for 1857, and at that time he employed an ordinary engraver's globe filled with acidulated water. In a note to the paper he states that a solid glass ball had been produced, and such spheres have entirely superseded the former arrangement.

Mr. Campbell placed his ball inside a bowl of mahogany, and thus obtained

[1] *Quarterly Journal*, p. 124.

No. of Hours recorded and Percentage of Possible Duration of Bright Sunshine.

Station and Year.	Jan.		Feb.		Mar.		April.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.	
	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.
Sandwick.	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o
1880	...	...	...	...	...	...	162	37	208	40	238	43	136	26	154	32	128	33	98	31	43	19	13	7
1881	44	21	35	14	59	17	123	28	211	40	149	27	143	27	130	27	78	20	71	23	31	14	27	15
1882	25	12	46	18	80	22	134	31	258	49	144	26	175	33	71	15	103	27	78	25	54	24	20	11
1883	44	21	54	22	58	16	137	32	174	33	195	35	170	32	96	20	96	25	91	29	51	23	17	9
1884	13	6	57	22	103	29	154	35	152	29	138	25	168	32	158	33	88	23	48	15	34	15	8	4
1885	9	4	45	17	54	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Stornoway.																								
1880	...	...	...	...	...	...	142	33	218	44	216	41	154	29	145	30	117	30	101	32	45	19	21	11
1881	39	18	56	22	80	22	162	37	197	39	183	35	119	23	130	27	89	23	101	32	19	8	29	15
1882	23	11	29	11	89	25	148	34	279	56	176	33	155	29	84	18	103	27	91	29	40	17	37	19
1883	51	23	57	22	127	36	159	37	135	27	202	38	128	24	90	19	127	33	101	32	58	25	23	12
1884	15	7	73	27	88	25	129	30	188	38	136	26	163	31	99	21	134	35	59	19	55	24	6	3
1885	15	7	57	22	94	26	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Aberdeen.																								
1880	...	...	...	...	...	...	135	32	211	42	186	35	160	30	138	30	150	41	98	31	84	36	45	21
1881	85	37	40	15	138	39	126	30	249	50	178	34	142	27	151	33	57	15	80	26	53	23	56	28
1882	64	28	93	35	138	39	112	27	247	49	193	37	220	42	167	37	102	28	85	27	51	22	20	10
1883	53	23	81	31	138	39	155	37	169	34	186	35	139	26	158	35	114	31	133	43	82	35	46	23
1884	59	26	60	22	79	22	134	32	169	34	160	30	141	27	182	40	138	37	90	29	47	20	24	12
1885	15	7	79	30	112	31	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Glasgow.																								
1880	...	...	...	...	...	...	139	33	187	37	205	39	162	31	141	31	99	27	98	31	32	13	22	11
1881	18	8	49	19	81	23	167	40	228	46	156	30	112	21	145	32	66	18	76	24	29	12	12	6
1882	11	5	37	14	85	24	124	30	212	24	148	28	128	24	159	35	89	24	42	13	18	8	14	7
1883	19	8	52	20	104	29	107	26	146	29	149	28	160	30	123	27	111	30	90	29	36	15	18	9
1884	17	7	38	14	56	16	100	24	142	28	110	21	108	21	111	24	111	30	52	17	33	14	3	1
1885	12	5	48	18	89	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Silloth.																								
1880	...	...	...	...	...	...	...	...	201	40	196	39	143	29	191	42	127	34	103	32	70	29	23	11
1881	53	22	58	22	101	28	169	41	264	53	171	34	132	26	138	30	105	28	113	35	39	16	39	18
1882	21	9	41	16	96	27	147	35	282	56	205	41	197	39	170	37	130	35	66	20	54	22	27	12
1883	46	19	65	25	140	39	150	36	218	44	184	37	174	35	138	30	116	31	112	35	73	30	27	12
1884	20	8	48	17	74	21	130	31	181	36	171	34	160	32	177	39	143	39	73	23	57	23	24	11
1885	27	11	51	19	115	32	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Durham.																								
1880	...	...	...	...	...	...	...	...	...	...	140	28	118	24	139	31	143	39	74	23	71	29	55	25
1881	51	21	38	14	123	34	110	26	256	51	140	28	168	34	145	32	66	18	94	29	53	22	51	23
1882	57	24	68	26	127	36	119	29	230	46	193	39	195	39	182	40	104	28	73	23	61	25	22	10
1883	41	17	82	31	132	37	131	31	213	43	132	26	158	32	167	37	99	27	103	32	81	33	...	...
1884	...	...	...	...	...	...	...	...	193	39	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Kelstern.																								
1880	...	...	...	...	...	...	138	33	193	41	156	31	118	24	155	34	168	45	85	26	66	26	46	20
1881	48	20	30	11	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Worksop.																								
1881	41	17	37	14	108	29	140	34	237	50	150	30	192	38	118	26	88	24	107	33	62	24	45	20
1882	40	17	48	18	118	32	142	34	248	52	157	31	163	33	179	39	109	29	74	23	73	28	16	7
1883	45	18	75	28	140	38	134	32	175	37	153	31	149	30	163	36	106	29	103	32	59	23	28	12
1884	23	9	58	21	92	25	106	25	201	42	149	30	147	29	206	45	117	32	77	24	42	16	14	6
1885	14	6	39	14	81	21	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Dublin.																								
1880	...	...	...	...	...	...	190	46	226	47	156	31	154	31	199	44	134	36	117	36	76	30	56	25
1881	63	26	61	23	119	32	141	34	273	57	161	32	151	30	140	31	103	28	122	38	98	38	63	28
1882	56	23	55	20	136	37	150	36	281	59	202	40	152	30	163	36	123	33	101	31	69	27	37	16
1883	74	30	77	28	128	35	195	47	207	43	154	31	126	25	155	34	136	37	114	35	94	37	48	21
1884	36	15	49	18	88	24	180	43	191	40	119	24	142	28	183	40	148	40	107	33	58	23	32	14
1885	51	21	88	33	120	33	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Llandudno.																								
1880	...	...	...	...	167	45	177	42	233	49	155	31	140	28	203	45	100	27	59	18	54	21	28	12
1881	70	29	66	24	85	23	136	33	254	53	194	39	161	32	103	23	105	28	114	35	53	21	...	...
1882	38	16	42	16	90	24	138	33	280	59	153	31	164	33	131	29	102	28	63	20	32	12	22	10
1883	51	21	88	33	102	28	140	34	214	45	183	37	149	30	152	33	113	31	90	28	58	23	16	7
1884	...	...	...	...	70	19	162	39	178	37	197	39	138	28	200	44	116	31	65	20	43	17	...	...
1885	...	...	45	17	96	26	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

No. OF HOURS RECORDED AND PERCENTAGE OF POSSIBLE DURATION OF BRIGHT SUNSHINE—*Continued.*

Station and Year.	Jan. Total.	Jan. Per Cent.	Feb. Total.	Feb. Per Cent.	Mar. Total.	Mar. Per Cent.	April. Total.	April. Per Cent.	May. Total.	May. Per Cent.	June. Total.	June. Per Cent.	July. Total.	July. Per Cent.	Aug. Total.	Aug. Per Cent.	Sept. Total.	Sept. Per Cent.	Oct. Total.	Oct. Per Cent.	Nov. Total.	Nov. Per Cent.	Dec. Total.	Dec. Per Cent.
	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o
BUXTON.																								
1881	...	...	...	...	...	...	...	...	...	...	...	...	165	33	107	24	79	21	91	28	42	16	40	18
1882	35	14	35	13	92	25	115	28	253	53	136	27	153	31	116	26	100	27	64	20	48	19	11	5
1883	32	13	64	24	104	28	129	31	177	37	157	31	161	32	165	36	87	23	60	19	56	22	36	16
1884	22	9	45	16	73	20	92	22	185	39	192	38	109	21	...	...	...	...	48	15	33	13	8	4
1885	8	3	19	7	82	22	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
PARSONSTOWN.																								
1880	...	...	...	...	...	...	166	40	212	45	166	33	157	31	168	37	117	32	120	37	62	24	51	22
1881	71	29	56	21	114	31	171	41	251	53	150	30	155	31	147	32	100	27	101	31	95	37	68	30
1882	48	20	56	21	122	33	149	36	264	55	207	41	143	29	153	34	138	37	102	32	59	23	37	16
1883	61	25	65	24	149	40	180	43	182	38	172	34	124	25	111	24	107	29	86	27	70	27	41	18
1884	24	10	57	21	78	21	169	41	179	38	129	26	150	30	144	32	136	37	75	23	60	23	32	14
1885	64	26	79	29	116	32	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
STRELLEY.																								
1881	...	...	...	...	110	30	146	35	231	49	153	31	191	38	106	23	90	24	115	36	63	25	48	21
1882	34	14	44	16	121	33	140	34	246	52	145	29	165	33	172	38	107	29	61	19	78	30	21	9
1883	50	21	71	26	130	35	142	34	187	39	160	32	139	28	161	35	103	28	93	29	6c	23	27	12
1884	21	9	49	18	86	23	100	24	206	43	132	26	129	26	206	45	116	31	69	21	39	15	14	6
1885	10	4	41	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
NEWTON-REIGNY																								
1883	...	...	...	...	...	...	...	...	215	43	154	31	157	31	134	29	106	29	106	33	51	21	22	10
1884	22	9	36	13	85	24	129	31	223	45	165	33	131	26	172	38	144	39	75	23	47	19	24	11
1885	20	8	35	13	94	26	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
ARMAGH.																								
1880	...	...	...	...	...	...	181	43	222	44	164	33	140	28	172	38	125	34	105	33	58	23	53	24
1881	57	23	43	16	130	35	156	37	236	47	160	32	118	24	137	30	82	22	115	36	77	31	63	28
1882	44	18	61	23	112	30	138	33	288	58	187	37	130	26	131	29	115	31	88	27	63	25	29	13
1883	56	23	64	24	135	36	167	40	181	36	157	31	134	27	113	25	104	28	66	20	59	24	26	12
1884	22	9	51	18	64	17	141	34	131	26	105	21	143	29	112	25	115	31	68	21	48	19	17	8
1885	47	19	69	26	88	24	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
MARKREE.																								
1880	...	...	...	...	...	...	179	43	206	41	206	41	144	29	156	34	118	32	118	37	58	23	36	16
1881	65	27	44	16	122	33	177	42	234	47	127	25	112	22	160	35	97	26	101	31	69	28	72	32
1882	43	18	49	18	129	35	137	33	265	53	151	30	124	25	120	26	121	33	113	35	56	22	27	12
1883	44	18	53	20	136	37	183	44	168	34	162	32	124	25	92	20	91	25	77	24	66	26	31	14
1884	22	9	51	18	73	20	153	37	159	32	113	23	139	28	123	27	99	27	65	20	56	22	18	8
1885	50	21	71	27	98	27	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
DOUGLAS, ISLE OF MAN.																								
1880	...	...	...	...	...	...	200	48	244	49	204	41	180	36	194	43	144	39	115	36	76	30	51	23
1881	67	27	69	26	119	32	181	43	279	56	206	41	142	28	142	31	112	30	102	32	56	22	71	32
1882	34	14	35	13	112	30	156	37	301	60	216	43	202	40	192	42	137	37	93	29	52	21	41	18
1883	43	18	74	27	166	45	177	42	235	47	210	42	216	43	173	38	134	36	108	33	88	35	39	18
1884	32	13	55	20	81	22	169	41	205	41	212	42	186	37	188	41	153	41	98	30	61	24	35	16
1885	32	13	64	24	127	35	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
YORK.																								
1881	...	...	...	...	...	...	143	34	272	54	155	31	174	35	137	30	78	21	96	30	44	18	27	12
1882	31	13	47	17	115	31	138	33	273	55	179	36	172	34	180	40	99	27	70	22	51	20	15	7
1883	22	9	71	26	133	36	135	32	201	40	170	34	154	31	164	36	100	27	94	29	48	19	29	13
1884	24	10	34	12	87	23	126	30	210	42	175	35	143	29	193	42	115	31	96	30	34	14	6	3
1885	3	1	29	11	69	19	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
STONYHURST.																								
1880	...	...	...	...	...	...	159	38	246	49	146	29	148	30	203	45	118	32	91	28	77	31	40	18
1881	64	26	48	18	97	26	160	38	267	53	169	34	147	29	118	26	110	30	119	37	33	13	18	8
1882	20	8	30	11	79	21	133	32	257	51	166	33	159	32	161	35	100	27	65	20	54	22	15	7
1883	36	15	63	23	146	39	154	37	205	41	170	34	159	32	167	37	111	30	83	26	55	22	24	11
1884	18	7	42	15	75	20	125	30	214	43	177	35	139	28	192	42	141	38	79	24	60	24	21	9
1885	11	5	35	13	98	27	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
BLACKPOOL.																								
1882	26	11	36	13	91	25	143	34	275	55	185	37	203	41	156	34	126	34	67	21	53	21	15	7
1883	42	17	71	26	...	...	164	39	224	45	202	40	191	38	171	38	123	33	85	26	64	26	21	9
1884	10	4	48	18	68	18	120	29	179	36	186	37	137	27	191	42	132	36	74	23	35	14	11	5
1885	0	0	49	18	112	31	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

No. of Hours recorded and Percentage of Possible Duration of Bright Sunshine—*Continued.*

Station and Year.	Jan.		Feb.		Mar.		April.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.	
	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.
Hillington.	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o
1880	...	...	...	...	...	...	135	32	212	45	166	33	152	30	136	30	131	35	48	15	41	16	40	18
1881	46	19	31	11	130	35	158	38	257	54	187	37	230	46	130	29	92	25	96	30	47	18	38	17
1882	32	13	38	14	110	30	142	34	267	56	159	32	221	44	160	35	127	34	71	22	41	16	15	7
1883	46	19	97	36	124	33	155	37	214	45	208	42	175	35	180	40	118	32	88	27	50	20	11	5
1884	19	8	72	26	98	26	145	35	230	48	209	42	170	34	222	49	136	37	93	29	41	16	14	6
1885	29	12	48	18	122	34	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Leicester.																								
1880	...	...	...	...	...	...	...	...	...	...	...	...	141	28	128	28	132	36	51	16	47	18	29	13
1881	24	10	38	14	108	29	133	32	216	45	156	31	197	39	117	26	85	23	105	33	67	26	50	22
1882	25	10	41	15	88	24	133	32	240	50	151	30	169	34	173	38	98	26	69	21	69	27	15	7
1883	49	20	76	28	90	24	123	30	171	36	170	34	132	26	156	34	93	25	88	27	62	24	16	7
1884	20	8	58	21	85	23	90	22	205	43	140	28	138	28	212	47	104	28	64	20	29	11	9	4
1885	12	5	44	16	90	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Churchstoke.																								
1880	...	...	...	...	...	...	127	30	197	41	140	28	174	35	147	32	114	31	71	22	65	25	39	17
1881	40	16	53	20	126	34	165	40	248	52	158	32	175	35	115	25	99	27	100	31	63	25	49	22
1882	41	17	50	19	132	36	135	32	244	51	155	31	163	33	164	36	118	32	66	20	54	21	20	9
1883	39	16	88	33	132	36	144	35	153	32	172	34	144	29	160	35	128	35	92	29	62	24	41	18
1884	24	10	46	17	104	28	121	29	224	47	176	35	152	30	211	46	142	38	93	29	41	16	23	10
1885	12	5	63	23	90	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Geldeston.																								
1880	...	...	...	...	...	...	...	...	...	...	...	...	...	...	171	38	156	42	77	24	87	34	52	22
1881	66	26	35	13	65	18	194	47	282	59	224	45	258	52	158	35	107	29	126	39	76	30	46	20
1882	34	14	57	21	173	47	171	41	290	61	188	38	234	47	189	42	140	38	98	30	96	37	37	16
1883	70	28	98	36	142	38	185	44	239	50	218	44	208	42	217	48	151	41	103	32	80	31	38	16
1884	43	17	69	24	108	29	145	35	235	49	218	44	193	39	229	50	168	45	102	32	51	20	23	10
1885	44	18	67	25	157	43	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cambridge.																								
1880	...	...	...	...	...	...	152	36	205	43	159	32	180	36	149	33	151	41	76	24	89	35	45	19
1881	61	24	28	10	137	37	181	43	236	50	181	36	229	46	146	32	93	25	124	38	76	30	50	22
1882	35	14	47	17	153	41	182	44	263	55	143	29	217	43	153	34	137	37	86	27	88	34	34	15
1883	60	24	85	31	149	40	164	39	189	40	203	41	169	34	176	39	125	34	103	32	91	35	31	13
1884	32	13	65	23	110	30	111	27	231	49	190	38	162	32	229	50	154	42	105	33	41	16	24	10
1885	25	10	57	21	123	34	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Aspley Guise.																								
1881	63	25	38	14	131	35	170	41	222	47	183	37	224	45	137	30	100	27	123	38	74	29	54	23
1882	40	16	47	18	143	39	157	38	246	52	135	27	184	37	154	34	133	36	75	23	72	28	38	16
1883	56	22	78	29	138	37	137	33	171	36	181	36	136	27	177	39	122	33	83	26	88	34	24	10
1884	29	12	60	21	97	26	102	24	215	45	147	29	134	27	224	49	134	36	87	27	42	16	15	6
1885	16	7	56	20	122	32	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Valencia.																								
1880	51	20	62	22	135	36	202	48	237	50	207	41	217	43	185	41	113	31	166	51	64	25	35	15
1881	128	51	72	27	127	34	162	39	287	60	161	32	122	24	133	29	126	34	92	29	66	26	64	28
1882	41	16	51	19	122	33	173	42	264	55	200	40	152	30	174	38	142	38	123	38	70	27	60	26
1883	38	15	49	18	178	48	198	48	232	49	219	44	134	27	142	31	113	31	90	28	58	23	36	15
1884	18	7	61	21	89	24	152	36	191	40	178	36	151	30	134	29	120	32	94	29	72	28	18	8
1885	50	20	62	23	136	37	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Oxford.																								
1880	...	...	...	...	157	42	142	34	204	43	135	27	186	37	145	32	124	33	86	27	75	29	38	16
1881	50	20	47	17	142	38	154	37	232	49	189	38	237	47	143	31	114	31	124	38	65	25	50	22
1882	35	14	41	15	138	37	174	42	259	54	150	30	192	38	151	33	147	40	70	22	81	32	27	11
1883	61	24	87	32	158	43	166	40	173	36	196	39	140	28	167	37	113	31	88	27	91	35	33	14
1884	30	12	62	22	103	28	104	25	201	42	164	33	152	30	232	51	135	36	93	29	40	16	24	10
1885	16	6	64	23	122	34	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
St. Ann's Head.																								
1880	...	...	91	32	121	33	180	43	247	52	183	37	257	51	229	50	133	35	112	35	80	31	36	15
1881	92	37	83	31	129	35	163	39	296	62	237	47	184	37	178	39	169	45	118	37	71	28	74	32
1882	35	14	60	22	105	28	174	42	282	59	242	48	207	41	182	40	143	39	95	29	69	27	34	15
1883	65	26	74	27	184	50	233	56	215	45	234	47	205	41	160	35	134	36	92	29	71	28	30	13
1884	20	8	41	14	119	32	177	42	205	43	216	43	208	42	221	49	164	44	93	29	47	18	29	12
1885	31	12	73	27	139	38	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

No. of Hours recorded and Percentage of Possible Duration of Bright Sunshine—*Continued.*

Station and Year.	Jan. Total.	Jan. Per Cent.	Feb. Total.	Feb. Per Cent.	Mar. Total.	Mar. Per Cent.	April. Total.	April. Per Cent.	May. Total.	May. Per Cent.	June. Total.	June. Per Cent.	July. Total.	July. Per Cent.	Aug. Total.	Aug. Per Cent.	Sept. Total.	Sept. Per Cent.	Oct. Total.	Oct. Per Cent.	Nov. Total.	Nov. Per Cent.	Dec. Total.	Dec. Per Cent.
CIRENCESTER.	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o
1880	...	...	...	...	...	...	132	32	216	45	150	30	168	34	152	33	106	29	82	25	76	30	42	18
1881	59	24	49	18	149	40	161	39	244	51	174	35	230	46	133	29	126	34	121	38	51	20	53	23
1882	34	14	45	17	118	32	164	39	262	55	149	30	160	32	159	35	132	36	66	20	83	32	34	15
1883	57	23	99	37	167	45	181	43	167	35	187	37	149	30	182	40	106	29	72	22	70	27	30	13
1884	30	12	60	21	92	25	102	24	197	41	164	33	127	25	220	48	116	31	100	31	39	15	13	6
1885	17	7	59	22	121	33	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
BUNHILL ROW.																								
1881	20	8	25	9	90	24	119	29	215	45	199	40	231	46	148	34	63	17	85	26	28	11	9	4
1882	6	2	7	3	67	18	110	26	215	45	133	27	176	35	123	28	84	23	45	14	34	13	1	0
1883	18	7	29	10	90	24	104	25	162	34	149	30	139	28	145	33	78	21	42	13	15	6	3	1
1884	10	4	24	8	50	14	72	17	167	35	122	24	135	27	201	46	105	28	56	17	17	6	0	0
1885	0	0	26	9	67	18	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
GREENWICH.																								
1880	42	16	53	19	141	38	133	32	193	41	133	27	169	34	106	24	119	32	52	16	54	21	19	8
1881	32	12	26	9	116	31	126	30	202	42	186	37	212	42	140	32	74	20	97	30	55	21	36	15
1882	16	6	36	13	128	35	151	36	238	50	121	24	195	39	126	29	99	27	60	19	56	21	18	8
1883	34	13	49	18	118	32	133	32	178	37	163	33	148	30	156	36	116	31	70	22	61	23	12	5
1884	17	7	46	16	86	23	88	21	184	39	134	27	127	25	203	47	119	32	59	18	39	15	13	5
1885	17	7	38	14	106	28	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
KEW.																								
1880	47	19	67	24	142	39	127	31	194	40	153	31	191	38	138	31	141	38	68	21	67	25	32	14
1881	33	13	27	10	111	31	133	32	224	46	214	43	251	51	160	36	95	25	110	34	63	24	43	17
1882	32	12	43	16	155	42	166	40	259	54	142	29	203	41	147	33	125	33	79	24	75	28	24	10
1883	46	18	72	26	142	39	156	38	206	43	186	38	168	35	180	40	129	34	86	26	81	30	32	13
1884	29	11	54	19	108	29	99	24	208	43	157	32	153	30	227	52	129	36	87	26	43	16	24	10
1885	16	6	54	19	107	28	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
MARLBOROUGH.																								
1881	...	...	...	...	...	...	...	...	...	...	...	...	246	49	154	35	119	32	133	41	62	24	51	21
1882	29	11	49	18	163	44	167	40	256	54	159	32	186	37	176	40	141	38	73	23	87	33	23	10
1883	53	21	92	33	167	45	173	42	179	38	189	38	157	31	184	42	122	33	91	28	67	25	30	13
1884	27	11	56	20	86	23	97	23	199	42	149	30	136	27	222	51	128	35	100	31	30	11	19	8
1885	17	7	49	18	115	32	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
CROYDON.																								
1880	...	...	...	...	...	...	153	37	196	41	144	29	193	39	134	31	124	33	52	16	60	23	25	11
1881	45	18	27	10	141	38	126	30	209	44	207	41	233	47	170	39	83	22	109	34	70	27	44	18
1882	30	12	48	17	156	42	169	41	265	56	137	27	210	42	148	34	112	30	78	24	65	25	22	9
1883	42	16	70	25	107	29	145	35	187	39	179	36	175	35	189	43	122	33	80	25	64	24	8	3
1884	24	9	57	20	97	26	103	25	191	40	129	26	162	32	226	52	121	33	72	22	22	8	8	3
HARESTOCK.																								
1882	32	12	59	21	161	43	197	47	258	54	171	34	193	39	191	44	166	45	82	25	94	36	38	16
1883	62	24	76	27	172	46	167	40	213	45	207	41	160	32	201	46	126	34	95	29	75	29	36	15
1884	31	12	55	19	100	27	113	27	219	46	173	35	145	29	237	55	134	36	113	35	40	15	20	8
1885	25	10	54	19	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
SOUTHAMPTON.																								
1880	...	...	...	...	...	...	...	...	247	52	162	32	199	40	189	43	140	38	84	26	...	...	30	13
1881	...	...	55	20	148	40	142	34	250	53	199	40	269	54	172	40	148	40	145	45	...	...	..	...
1882	23	9	61	22	165	45	204	49	253	53	184	37	214	43	197	45	169	46	89	28	92	35	35	15
1883	60	23	75	27	180	49	189	45	217	46	214	43	179	36	201	46	127	34	101	31	69	26	41	17
1884	31	12	52	18	111	30	115	28	215	45	189	38	159	33	245	56	141	38	120	37	45	17	23	10
1885	19	7	52	19	133	37	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
CULLOMPTON.																								
1881	...	...	...	...	...	...	...	...	...	...	...	...	225	45	150	35	140	38	116	36	52	20	47	20
1882	28	11	54	19	145	39	163	39	239	50	171	34	182	36	189	43	145	39	71	22	78	30	21	9
1883	44	17	79	28	178	48	174	42	155	33	169	34	162	32	173	40	127	34	88	27	65	25	37	16
1884	15	6	42	15	98	26	120	29	218	46	194	39	152	30	210	48	137	37	80	25	26	10	8	3
1885	21	8	46	17	112	31	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
ST. LEONARD'S.																								
1882	...	...	...	...	...	...	...	...	...	...	...	...	...	...	170	39	120	32	103	32	101	38	43	18
1883	62	24	86	31	177	48	196	47	249	52	249	50	207	41	207	48	130	35	130	40	93	35	39	16
1884	47	18	90	32	130	35	134	32	225	47	179	36	202	40	267	61	139	38	108	33	65	25	27	11
1885	35	14	70	25	157	43	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

No. of Hours recorded and Percentage of Possible Duration of Bright Sunshine—*Continued.*

Station and Year.	Jan.		Feb.		Mar.		April.		May.		June		July.		Aug.		Sept.		Oct.		Nov.		Dec.	
	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.	Total.	Per Cent.
SOUTHBOURNE-ON-SEA.	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o	hs.	o/o
1880	...	...	...	...	...	...	170	41	229	48	138	28	208	42	152	35	142	38	78	24	69	26	34	14
1881	53	21	56	20	136	37	145	35	252	53	198	40	271	54	176	40	137	37	137	42	74	28	61	26
1882	38	15	77	28	161	43	190	46	289	61	191	38	204	41	207	48	157	42	97	30	96	36	29	12
1883	58	23	90	32	169	46	167	40	216	45	216	43	193	39	214	49	110	30	95	29	78	30	41	17
1884	35	14	59	21	111	30	110	26	216	45	196	39	163	33	229	53	118	32	106	33	42	16	20	80
1885	30	12	30	11	127	34	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
PLYMOUTH.																								
1881	...	...	...	...	...	...	141	34	270	57	198	42	238	50	165	38	153	41	148	46	50	19	61	25
1882	36	14	68	24	142	38	171	41	258	54	183	38	202	42	185	43	148	40	76	24	65	25	27	11
1883	48	18	73	26	177	48	199	48	170	36	193	41	162	34	167	38	134	36	98	30	69	26	46	19
1884	17	6	39	14	116	31	155	37	201	42	212	45	159	33	232	53	153	41	85	26	42	16	26	11
1885	29	11	49	18	139	38	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
FALMOUTH.																								
1880	...	...	...	...	...	...	180	43	269	56	170	36	228	48	190	44	114	31	96	30	78	30	...	...
1881	63	24	72	26	141	38	117	28	281	59	256	54	238	50	191	44	191	52	148	46	84	32	...	...
1882	29	11	85	31	156	42	184	44	256	54	212	45	234	49	192	44	139	38	109	34	77	29	40	16
1883	55	21	83	30	186	50	196	47	169	35	208	44	177	37	179	41	133	36	98	30	83	32	49	20
1884	22	8	51	18	97	26	165	40	217	46	236	50	214	45	217	50	139	38	104	32	45	17	27	11
1885	40	15	47	17	136	37	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
ST. AUBIN'S, JERSEY.																								
1880	...	...	...	...	...	...	181	43	283	59	161	34	248	52	166	38	151	41	116	35	74	27	31	12
1881	100	37	76	27	135	36	134	32	266	56	257	54	284	60	233	54	181	49	161	48	76	28	76	30
1882	41	15	113	41	163	44	213	51	273	57	203	43	220	46	239	55	170	46	114	34	68	25	30	12
1883	70	26	114	41	174	47	229	55	246	52	246	52	230	48	241	55	137	37	102	31	66	24	32	13
1884	50	19	86	29	168	45	176	42	266	56	258	54	172	36	258	59	179	48	133	40	86	32	24	10
1885	43	16	75	27	160	44	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Note.—At Oxford the day's sunshine is reckoned from noon to noon.

a six months' record; this instrument was at first fixed on the roof of the General Board of Health in Parliament Street, and the register commenced with the winter solstice of 1854. Several of the bowls are here exhibited. Mr. Campbell reproduced the records for eighteen months, in the *Report on the Warming and Ventilation of Buildings* by a Commission of which he was Secretary. After the winter solstice of 1857 a glass ball was substituted for the original engraver's globe.

On the retirement of Mr. J. C. Haile from the Board of Health in 1875 the instrument was transferred to the Meteorological Office, and since that date the record has been kept up at Kew Observatory. Professors Roscoe and B. Stewart published in the *Proceedings of the Royal Society*, Vol. XXIII., a paper on the results of a rough mode of testing the amount of wood burnt for the twenty years 1855-74.

As soon as the record came to the Office I endeavoured, with the assistance of Mr. R. J. Lecky, to secure a daily record, as described in my paper in the *Quarterly Journal*, Vol. III. p. 18, and this eventually resulted in Prof. Stokes's Sunshine Recorder, which was completed in 1879 and first issued to the stations in 1880.

Various forms of support have since been devised, but none of them approach Prof. Stokes's for simplicity of arrangement.

I have obtained all the records from these instruments for the last five years, or for shorter periods, and have tabulated the total number of hours for calendar months, and the percentages of possible duration of sunshine taking the nearest parallel of latitude. The maps are exhibited in the next room, but it is not proposed to publish them, the time is too short, and the influence of the omission of one month, which occasionally occurs, is too serious. For instance, the record for Blackpool in January is from 1882-85, from Stonyhurst from 1881-84, and they differ by nearly 50 per cent. of the Stonyhurst record. The figure for Stonyhurst is 14, and for Blackpool only 8. Accordingly, to publish the maps might lead to serious misconceptions. If I had rigidly excluded every station at which a month was missing from any cause my list would have been short.

The features which strike any one on examining the maps of sunshine, which are for the most part for the five last summers and for the four last winters, excluding January to March 1885, which has not yet expired, are :—

Firstly, the broad fact that the extreme South-western and Southern stations are the sunniest. As has already been frequently pointed out, Jersey undoubtedly is the most favoured of our stations in this particular.

Secondly, that, in the late autumn and winter, Ireland is much sunnier than Great Britain, Dublin having absolutely the highest percentage of possible duration of sunshine in November, and being only equalled by Douglas (Isle of Man) in December and by Jersey in January. The Dublin instrument is not situated in the City, but at the Mountjoy Observatory in the Phœnix Park to the westward of the Viceregal Lodge.

The North-east of Scotland is also exceptionally bright, as the station, Aberdeen, lies to the leeward of the Grampians.

In April the line of 40 per cent. of possible duration takes in Jersey, Cornwall, Pembrokeshire, the Isle of Man and the whole of Ireland, except Armagh.

In May we find the absolute maximum of the year, and the amount rises to 50 per cent. (nearly to 60 in Jersey) over the district just described as enjoying 40 per cent. in April.

In June we have a falling off, which is continued into July, and even into August in the West Highlands. In the South of England, however, we have in August a second maximum, the figure for Jersey even rising to 50 per cent. This is mainly due to the exceptionally bright weather of August, 1884, in the Southern counties of England.

In September Ireland shows a falling off, and we find the greatest amount of cloudiness in Lincolnshire. In October the Midland Counties of England are the worst off.

In November the lines indicating 30 per cent. enclose two districts—one Dublin, already mentioned; and the other the Eastern Counties, Cambridge and Geldeston, near Beccles.

The absolutely highest monthly percentages in the period under considera-

tion are in the months of May 1882, in which St. Ann's Head, Milford Haven, has 62 per cent., while Geldeston (already mentioned), Douglas (Isle of Man), and Southbourne, near Bournemouth, show 61 per cent.

The instruments from which the records have been taken are all on Prof. Stokes's principle, except that at Greenwich, which was constructed under the directions of the late Mr. Campbell.

The Tables give the total duration and the percentage of possible bright sunshine for each month from April 1879 to March 1885.

DISCUSSION.

Mr. B. WOODD SMITH said that he had worked four sunshine recorders together at the same time, and had found that the registers did not agree, the indications from two of the instruments placed side by side differing very considerably. He considered it was necessary that the instruments should be compared and tested before they were sent out to observers. The comparison should be carried on for a considerable time, because the difference of recording power showed itself more in some conditions of weather than in others.

The PRESIDENT (Mr. Scott) said that errors in the registration of sunshine were not so much due to the quality of the glass sphere, but rather to differences in the construction of the support or frame. In 1880 the authorities at Lloyd's had a sunshine recorder erected on the Royal Exchange, but after a time they sold it, probably because they believed it did not register sufficient sunshine. It was bought by a gentleman who set it up at his residence in Surrey. A comparison had been made between the registers of this instrument and the amount of sunshine recorded at Bunhill Row, and it was found that in winter the Surrey Hills had the largest amount of sunshine, but after the spring equinox the largest amount was registered at Bunhill Row, in some cases amounting to nearly double that recorded on the Surrey Hills. In one month 231 hours were recorded in London and only 132 on the Surrey Hills. It was, of course, absurd to suppose from the results of this comparison that the Surrey Hills were less sunny than London, and in fact it was quite clear that the results must be due to a defect in the instrument in Surrey.

Mr. LECKY inquired whether the instrument on the Surrey Hills was made to be used with parallel cards, because if so, this would account for the defective record. He thought that in the case of Mr. Smith's instruments the differences must have been due to the focus of one of them falling short of the card.

Mr. ARCHIBALD agreed with the President that the period for which sunshine records were discussed was too short to base any conclusions upon. He thought that the amount of cloud and sunshine varied very much locally, and was greatly influenced by local peculiarities. For instance, from M. Renou's chart of isonephic lines it appeared that at Valencia, in Spain, there was an abnormal amount of sunshine, and he believed this was due to the peculiar configuration of the land in that district. The whole subject of sunshine records was very markedly a local one, and in order to obtain some idea of the distribution of sunshine it would be advisable to get as many recorders as possible, in just the same manner as rain-gauges were multiplied in a district in order to ascertain the local variations in rainfall.

Mr. BUDD remarked that the early spring was generally believed to be much brighter than the decline of the year. He should like to know if this was really the case.

Captain TOYNBEE said that the results of Mr. Smith's comparison of the registrations of sunshine recorders certainly seemed to suggest the desirability of instituting comparisons of the instruments at Kew, by which means a connection might probably be got out for back observations as well as for those taken in future.

Mr. WHIPPLE said that if sunshine recorders were coming into general use it certainly would be necessary to compare them with a standard instrument. Some time ago he was making experiments with a recorder which after a certain time of

the day got out of focus. He could not at first discover the cause, but after a while found that it was due to a want of uniformity in the refrangibility of the glass sphere, one half of the glass being of better quality than the other. There was about a ¼ inch difference between the foci of two halves of the sphere, and it was possible that there were other spheres like it; such a difference could not be discovered from a mere inspection. It sometimes happened, too, that the mountings were wrongly made, and he regretted that in the case of the Whipple-Casella instrument some of the first constructed were, by mistake, sent out with improper cardholders. Observers did not generally expect to register sunshine from the North-east or North-west, and therefore obstructions to the North of the instrument were sometimes disregarded. Some years ago, at the Kew Observatory, a gap in the record was noticed to occur with remarkable regularity in the evening, which eventually was discovered to be caused by a post intercepting the sun's rays, although situated on the northern side of the instrument. The President's Paper was really a tentative one, and not a Paper on which very close arguments were to be based.

Mr. SYMONS thought it would be better to send a standard instrument round successively to all the observers, so that they might be compared *in situ*, and by that means avoid that break in the records which would be caused if the instruments were sent to Kew. If printed instructions in the use of the instrument had not yet been prepared, it was clearly desirable that they should be.

Mr. STANLEY remarked that the readings being taken on three flat planes the cards could not be in focus, as the sun's altitude varied at different seasons. The burning power varied considerably, whether the sphere was in or out of focus. In three sunshine recorders he had compared the metal work was not so nearly in the focus of the sphere as it might be. He thought the metal work should be made specially to each sphere if the spheres could not be made similar.

Mr. CURTIS said there appeared to be a tendency to exaggerate the liability to error in consequence of a sunshine recorder being out of focus. He considered it was neither necessary to send the instruments to Kew nor to send other instruments to the observers for purposes of comparison, since by an examination of the spot of light produced by the lens upon the card, and of the character of the trace, it was perfectly easy to verify each instrument *in situ*. In the case of the instrument referred to by Mr. B. Woodd Smith the lens was simply out of focus, and that fact would be shown by the breadth of the burn on the card, and by there being no burn at all unless the sun was shining very strongly. Most instruments of Prof. Stokes's pattern had an arrangement for adjusting the focus of the lens.

Mr. LAUGHTON thought that amateur observers could scarcely be expected to detect errors quite so easily as Mr. Curtis supposed. To do so seemed to him to require a considerable amount of trained skill and of familiarity with the instrument. So also with regard to a standard circulating through the country, in the manner suggested by Mr. Symons, he should like to know how many amateurs would be equal to finding out such a curious source of error as that described by Mr. Whipple.

Mr. GASTER said that it is well to remember that fog, even low fog, cuts off the heat rays in sunshine almost as much as cloud, and it is especially necessary to make allowances for this in comparing records of sunshine made in large towns with those made at country stations, and those made in valleys with those made on the sides or summits of hills. Observations made in London or the valley of the Thames are not at all true exponents of the prevalence of bright sunshine over the South-east of England.

Mr. B. WOODD SMITH remarked that it was not always possible for an ordinary observer to detect errors in the registrations of his sunshine recorder: first, because the sun's image on the card being always more or less undefined, there is no absolute standard of definition; and secondly, because, owing to the cost of the instrument, no observer is likely to possess himself of more than one, so as to be able to detect discrepancies, unless under exceptional circumstances and for a special purpose.

Mr. LECKY said that the overlapping of the ends of the cards sometimes caused defects in registration.

Mr. MARRIOTT considered it desirable that a code of instructions for observers should be drawn up by the Council or by the Meteorological Office for the proper

management of sunshine recorders, both as regards the instrument and also the measurement of records.

Mr. ROUS-MARTEN remarked on the discrepancies existing among anemometers and solar radiation thermometers, as well as among sunshine recorders. He had also frequently observed in New Zealand that with a high solar radiation temperature there was a comparatively low maximum shade temperature, and he had recorded as much as 100° difference between the registrations of the two thermometers. In fact, his observations had led him to the conclusion that it was impossible to establish any decided connection or relation between the two, especially as the time of the maximum reading was not coincident in the two instruments.

The PRESIDENT (Mr. Scott) in reply said that an inspection of the monthly charts of sunshine which he exhibited showed that the stations really supported each other remarkably well, and that month after month the registers from the different stations practically agreed; and this too in spite of different modes of measurement, so that the Fellows should not go away from the Meeting with the idea that no two sunshine records ever accorded with each other.

REPORT OF COMMITTEE ON DECREASE OF WATER SUPPLY. (Plate V.)

[Read April 15th, 1885.]

IN the year 1875, at the instance of the Imperial Academy of Sciences in Vienna, a Joint Committee, representing the Meteorological Office and the Royal Meteorological Society, was appointed to take into consideration the question of "the decrease of water in springs, streams and rivers," and also the "simultaneous rise of the flood-level in cultivated countries."

On the appointment of the Committee a translation of the letter from the Academy, together with a circular signed by Robert H. Scott, Director of the Meteorological Office, and G. J. Symons, Secretary of the Royal Meteorological Society, was transmitted to a number of persons in this country, with a view to elicit information upon the several points referred to.

The replies received in response to this circular were as follows:—

1. A communication from the Rev. James C. Clutterbuck, M.A., dated September 23rd, 1875, which has been supplemented by a return of well measurements furnished to Mr. Baldwin Latham.

2. A return from Mr. William Vicary of the floods in the River Exe at St. Thomas's, Exeter, from 1800 to 1866, since supplemented by a return from Mr. A. Bodley.

3. Mr. John Taylor, M.Inst.C.E., whose records of the gaugings of the River Thames at Seething Wells were published in the *Sixth Report of the Rivers Pollution Commissioners*, at the request of the Committee supplied the results of the gaugings up to the end of the year 1879.

4. Several letters were received on the subject referred to in the circular, but no further information available for the purpose of this inquiry was elicited.

5. A record of the measurements of the water in a number of wells in the vicinity of the Kennet and Avon Canal, commencing in 1835 and terminating in 1863, was supplied to Mr. Symons, the copy having been made by the Rev. T. A. Preston in 1866. The return was accompanied by a number of special reports made in 1854 and 1855, at which period the

water in the ground was remarkably low, the Kennet and Avon Canal having suffered severely in consequence. These records were commenced by Mr. T. E. Blackwell, M.Inst.C.E., and were continued by Mr. R. W. Merriman, Secretary of the Company, when Mr. Blackwell's engagements took him away from this country. The records were handed over to Mr. Baldwin Latham in 1880, who selected one well in the list of wells measured, and has had it regularly gauged up to the present time, together with other wells in various parts of the country.

The records now available for the purpose of determining the question under consideration consist of:—

1. A valuable series of Rainfall Tables. These tables, however, throw very little light upon the question of the diminution of water supply, as the quantity of water available in any one period largely depends upon the amount of water which is stored in the ground previous to the time of rainfall.

2. A record of the height of the water in the Godstone Stone Quarries from 1843 up to the present time, with the exception of the years 1858, and from 1868 to 1872. The height to which the water rose, and the date, have been marked upon the walls of the Quarry. The levels of these heights were determined ten years ago by Mr. Baldwin Latham, and a similar record has been kept up to the present time.

3. A long record of the gaugings of a well at Chilgrove, which was commenced in 1836 and has been continued up to the present time, the measurements having been recorded by Mr. Leyland Woods and his father. This record gives, approximately, a very fair representation of the amount of water stored in the ground in any particular year in that part of the country.

4. A record was kept at Wickham Court, Kent, the residence of Colonel Sir John F. Lennard, Bart., by his late steward, Mr. Charles Ward. The record was furnished to Mr. Baldwin Latham, who has continued the record up to the present time. In the records from Wickham Court it appears that Dr. Chas. H. Allfrey had supplied to Col. Sir John F. Lennard a record of the years when a bourne flowed out of the gravel pits at Orpington, Dr. Allfrey stating that the record was originally supplied by Mr. John Colgate, the oldest inhabitant in the neighbourhood, in order that the dates might be compared with the bourne flows, which occasionally appear in the valley below Wickham Court. The record shows the highest water and when it occurred in that part of the county of Kent.

5. A valuable record has been supplied to Mr. Baldwin Latham by Mr. Hubert Thomas, M.Inst.C.E., of the gaugings of the Wendover Spring from 1841 to the present time. The records of this spring have been taken to show the quantity of water supplied to the upper reaches of the Grand Junction Canal at Tring. The record shows the quantity of water flowing from the spring during every month of the year.

6. The percolation experiments which were commenced by Messrs. Dickinson and Co. at Nash Mills, Hemel Hempsted, in 1835, and have been continued by Dr. John Evans, F.R.S., furnish a valuable record of the quantity of water which percolated into the ground in any one year, and therefore

may be taken as a guide as to the probable state of the springs in these years. It should, however, be borne in mind in considering these percolation experiments that these do not record the amount of water stored in the ground at the period when percolation commences, so that they are not to be relied upon as giving a correct record of springs or streams flowing from the ground.

7. In the *Report of the Royal Commission on Water Supply* in 1868, there is a record showing the gaugings of the River Lee from 1850 to 1868. These have been supplemented by other gaugings, which were collated by the late Mr. Charles Greaves, M.Inst.C.E., past President of the Royal Meteorological Society, and which bring the records up to 1882. From this period the record has been supplemented by Mr. W. B. Bryan, M.Inst.C.E., bringing the results down to 1884.

8. A record of the Well at Bury St. Edmunds Waterworks, from 1860 to 1864, furnished by Mr. J. Croft, and a record of the same Well from 1876 to the present time, supplied by Mr. J. Campbell Smith.

9. A record of well measurements at Cirencester from 1868 to 1868, supplied by Mr. J. C. Brown, and which appear in the *Report of the Royal Commission on Water Supply*. This published record has been supplemented by Miss Brown with records extending up to 1875, and a new series of observations have also been commenced by Miss Brown.

10. A record which was discovered by Mr. Symons in the *Philosophical Magazine* for February, 1882, of a Well at Hartlip Place, Sittingbourne, Kent, the record, extending from 1819 to 1881, having been kept by Mr. W. Bland. This Well has recently been measured by Mr. Baldwin Latham, and the result shows that no material alteration has taken place, although the well has been deepened since the original measurements were taken, and therefore the present state of the water in the Well can be compared with the former records.

11. The Rev. J. C. Clutterbuck[1] furnished a series of diagrams of a Well at Wittenham Furze, near Long Wittenham, showing the quantity of water in the ground at all periods between 1868 and the present time. Mr. Clutterbuck has also permitted his opinion upon the question of underground water to be communicated to the Committee, viz. that after great experience in such matters, in his judgment there was no real diminution in the water supply of this country, and that he had much greater fear for the incessant and increasing pumping from the chalk stratum in and about London than he has for any diminution of rainfall affecting the volume of the streams. Mr. Clutterbuck's observations in the neighbourhood of Watford show that in 1864 the water was very low, and in 1852 that it was very high—results which accord with many other records.

12. A record of the daily height of the water in the River Thames at Chelsea from 1841 to 1857, and the height of the water in the Thames at Surbiton from 1854 to 1880, which has been kept by the Chelsea Water

[1] We regret to say that Mr. Clutterbuck has deceased since the date of reading of this paper.—Ed.

Works Company, and a copy of which has been permitted by Mr. Llewellyn Lea to be made by the Meteorological Council.

13. A record of the state of the water and the amount of pumping at the Surrey County Lunatic Asylum at Wandsworth, from 1875 to 1884, a copy having been permitted to be taken by Dr. Strange Biggs, the Medical Superintendent.

14. A record of the state of the water in the Well at the Caterham Lunatic Asylum from 1872 to 1876 and from 1883 to 1884, supplied by Mr. Wm. Crickmay, A.M.Inst.C.E.

15. An account of the state of the water in the Wells at the Lunatic Asylums of Hanwell and Colney Hatch, extending over the period when the Wells were first sunk up to the present time, has been furnished by Mr. B. Woodd Smith.

16. A record of the floods in the Rivers Severn and Wye, with observations on the Floods, has been furnished by Mr. H. Southall, and the same gentleman has sent in a copy of a paper prepared by him and published in the *Proceedings of the Woolhope Naturalists' Field Club* for 1870, containing interesting notices of periods of droughts, floods, and other meteorological phenomena.

17. A number of isolated records exist as to periods of drought and flood in many places; for example, it appears from the Royal Commission on Water Supply in 1828 that there was a drought in July and August 1827. There was also a flood in the Thames in 1821, when the water rose ten feet above its ordinary height. In the *Metropolis Water Supply Inquiry*, 1852, it is shown that there was a severe drought in May 1852. Chadwell Springs were never lower than at this date, and the Hampstead Water Company got into difficulties owing to the lowness of the water supply. There was a drought in the River Lee in 1821, and there was no drier period for that river than March 1852. Droughts were experienced in 1850 and June 1852. The drought of 1864 is mentioned in the report of Sir Henry Tyler, in the *Report of the Select Committee on the East London Water Bill* in 1867, and it appears from this Report that the drought in that year was also felt in Scotland and in the valley of the River Ouse, which was a source at that time under consideration for the supply of water to East London. It also appears from the same Report that the water in the River Lee was very low in 1868.

As far as any inference can be drawn it appears that the years 1820, 1821, 1824, 1835, 1838, 1845, 1847, 1850, 1854, 1855, 1858, 1859, 1864, 1865, 1871, 1874, 1875 and 1884 have been periods of marked low water. On the other hand, the years 1817, 1825, 1830, 1836, 1841, 1842, 1853, 1860, 1861, 1866, 1873, 1877, 1879, 1881 and 1883 have been periods when there has been exceptionally high water. In 1852 the water was very low in the early part of the year, while at the end of the year it was very high. In the intervening periods the water has been of moderate altitude. It does not appear from existing records that there is any diminution in the water supply of this country, and the large quantity of water which has been

stored or has flowed off the ground between 1876 and 1884 is confirmatory of this view. There appear, however, to be periods when there is exceptionally low water, and these are almost immediately followed by periods of exceptionally high water.

With reference to the increase of floods, it does not appear from the records that there is any great increase in the height to which the floods rise in this country. The highest recorded flood in the River Thames appears to have been on January 28th, 1809. On this date at Henley-on-Thames it rose to 109·28 feet above Ordnance datum, and on February 14th, 1883, it rose 106·83 feet at the same place. In the *Report of the Select Committee on Thames Floods Prevention (Upland Waters)*, 1877, the height of the flood marks are given by Mr. Curtis and Mr. Holgate from 1821 to 1877. These returns have been supplemented by Mr. Albert Curtis, so that the height of the Thames Floods are brought up to the present time, from which it appears that the floods were higher in 1821 than in any subsequent period. The flood return for Exeter also shows that the floods were much higher in 1800 and 1810 than at any subsequent period. The flood returns of the Severn and Wye show that the highest floods occurred some years since, and that eight high floods occurred in eighty-two years between 1770 and 1852, and in the thirty-two years which have since elapsed no floods comparing in height with former floods occurred in these returns; the highest flood in the series occurred on November 18th, 1770.

Whether or not the height to which floods have risen in recent years has been affected by river improvement and the greater facility with which floods can be got rid of, or whether there is a diminution in the quantity of water, are questions upon which the Committee have not at present sufficient information to speak positively.

Upon the diagram (Plate V.) have been plotted the results of the investigations as far as contained in the accompanying report.

Winter Rainfall. The upper line on the diagram shows the winter rainfall in the London District for six months, commencing October 1st in one year and terminating on March 31st in the following year.

Yearly Rainfall. The second line indicates the yearly rainfall in the London district. The year, however, in this case commences on October 1st in one year and terminates on September 30th in the following year, thus including the period in which ordinary replenishment and subsequent loss of water in the ground take place.

Godstone Quarries. The height of the water in the Godstone Stone Quarries is next given. These quarries are located at the top of the escarpment of the North Downs, above the village of Godstone. The levels are reduced to the height above Ordnance datum, and indicate the highest point to which the water has risen in the Quarries in each year.

Hartlip Place. The gaugings of a well in the chalk situate at Hartlip Place near Sittingbourne, are from records taken by Mr. J. Bland between the years 1819 and 1880. The diagram shows the average depth of the water in the Well by taking a mean of all the observations in the year.

Wendover Spring. The line upon the diagram shows the quantity of water flowing from the spring between 1841 and 1884. The quantities indicated are the yearly averages in cubic feet per minute.

Durman's Well. This Well is sunk in the chalk at Collingbourne Kingston, Wiltshire. The line on the diagram indicates the average depth of the water in the well every year from 1841 to 1862, and from 1881 to 1884.

Chilgrove Well. The well at Chilgrove is sunk in the chalk at Chichester, Sussex. The diagram records the depth of the water in the Well from 1837 to 1884, with the exception of some few years in which, owing to the absence of observations, a complete average could not be taken.

East Grafton. The Well at East Grafton, Wiltshire, is also a well sunk in the chalk. The diagram gives the average depth of the water in the well every year from 1835 to 1862.

River Lea. The gaugings of the River Lea from 1850 to 1884 are indicated by the average quantity of water yielded by this river, reduced to cubic feet per minute on the average of each year, and include the water abstracted by the London Water Companies.

Wickham Court. The Well at Wickham Court, Kent, is sunk in the chalk. The diagram shows the average depth of the water in the well every year from 1866 to 1884.

Percolation Experiments. Messrs. Dickenson and Evans's percolation experiments show the annual quantity of water percolating through the ground gauge at Nash Mills, Hemel Hempstead, from 1835 to 1884 inclusive. The year in this case, as in the yearly rainfall records, is made to terminate at the end of September in each year.

Thames Floods. The height of floods in the Thames at Staines is shown on the diagram. The inches on the percolation scale correspond with feet on the gauge at Staines.

Croydon Bourne Flows. This is a record of the years when a Bourne flowed in the Caterham Valley above Croydon, and records the periods when there was a considerable amount of water stored in the ground.

Orpington Gravel Pits, Orpington, Kent. This is a record showing the years when the water flowed out of these pits, and shows the years when there was a large store of water in the ground.

DISCUSSION.

Mr. BRYAN quoted figures giving the rate of the flow of water in the River Lea at Field's weir, from which it appeared that in January 1885 the water was lower than the mean monthly flow for several years past. With respect to the diminution in water supply, he said that Mr. Docwra, who had had great experience in well-sinking in the London district, had given him particulars of a number of wells, showing that the depth of water had decreased to the approximate extent of a foot every year for the last forty years. This was due to the increased volume pumped.

Mr. G. DINES said there was one point connected with the subject upon which he would say a few words, viz. whether the rainfall of the country was changing. Twenty years ago it was thought to be decreasing, but only two years ago the contrary opinion was expressed. The decision on this point must be left for the future, as at present there were not sufficient data to decide the question. He

had thought that the recent drought might have been caused by the time at which the rain fell, as it was generally considered that the rain which fell in the winter penetrated furthest into the ground. He had therefore taken out the monthly rainfall of the last few years, and divided it into two portions, winter and summer. There was not much to be obtained by this method, but one fact came out very clearly, viz. the rainfall of the last two years was much below the average. Something very similar also occurred in 1864. The drought of 1852 was preceded by three years of rainfall each under the average, but the heavy rainfall in the latter part of that year soon restored matters to their natural state.

The rainfall of the last three or four years had been rather even, there was no instance of two or three wet months in succession, which would have helped the underground supply. In these remarks he was speaking of the London district only. He believed these droughts to be caused mainly by deficient rainfall, and the only cure was a wet year; this was not pleasant to think of, but after all it was not an unmixed evil, if it gave a better supply of water.

Mr. ROGERS FIELD congratulated the Committee on the amount of information contained in the Report, without which it was impossible to settle the question of the alleged decrease in water supply. Any one who had much to do with water supply knew that there were series of years of high and of low supply, but the question to be settled was whether on a long average of years an actual diminution in the water supply was really taking place. To do this it was of course necessary to study a long and uniform series of observations, which was exceedingly difficult to obtain. He thought the depth of water in wells was probably the best information to work upon, as such observations were generally more reliable than other records of water supply. It was, however, essential that the observations should be taken on wells when there was not much pumping going on, otherwise the measurements would not give the natural level of the underground water. For instance, in the London basin the continuous pumping had so greatly depressed the level of the underground water that observations there would be altogether misleading. He would strongly impress on the Council the importance of pnblishing the details of the information collected by the Committee.

The Rev. J. CLUTTERBUCK in a letter to the Secretary said: "I regret at my advanced age I am not able to attend the Meeting on the 15th. I cannot too strongly re-affirm the statement quoted from me in the Report, though I cannot expect to live to see the mischief I anticipate from pumping water from the chalk. I believe that my fears are not without foundation. I think the Report most valuable from the numerous facts which it records. If by answering inquiries by persons interested in this I can throw light on this important question, it will give me great pleasure to do so."

THE PRESIDENT (Mr. Scott) said that the credit of collecting the information and of drawing up the Report was really due to Mr. Baldwin Latham, as he had done all the work. It had been remarked by some of the speakers that last year had been one of deficient rainfall, but he wished to remind the Fellows that it was not so all over the country, as in the extreme North-western district of Scotland 1884 had been a year of excessive rainfall.

Mr. BALDWIN LATHAM said with reference to floods that in the year 1809 the floods in the Thames were higher than at any subsequent period, and then came the flood of 1821, which was also higher than at any subsequent period, but not so high as the flood of 1809. The floods in the various rivers respecting which information had been collected clearly showed that there had been no increase in the volume of floods in recent years. Whether the diminution of the rise of the water in these rivers was due to river improvements, or to an actual diminution in the quantity of water in flood time, it was not possible to state when judging by such records only; but collateral evidence obtained from other sources, especially in connection with the store of underground water, confirmed the fact that floods had not increased, and also showed that there was no decrease in the water supply of this country. The measurement of the water in wells clearly showed that there were periods of extreme low water, which were often immediately followed by periods of high water; but the experience gained since 1876 clearly showed that there had been no actual diminution in the volume of water, and the water in wells unaffected by pumping had risen as high as it did a century ago. With regard to the wells in the London basin, or those

immediately in or around London, such wells could not be taken as a guide of the state of underground water, as it was well known that the constant pumping of these wells had had the effect of gradually lowering the water-line at the rate of about one foot per year for many years past. It was known that London wells which were affected by the constant pumping had a fluctuating water-line not directly due to seasonable fluctuation, but to the varying quantity of water taken at one period compared with another period of the year. It was clear that this fluctuation was not due to seasonable fluctuation, but that the rise of the water was due to the diminished amount of pumping at certain periods of the year when the water rose in the wells. The rise due to this diminished pumping often occurred in the same period when the water in the wells in which there was a seasonable fluctuation was still falling, so that by noting the difference in the period of the rise and fall of the water the true cause of these fluctuations was ascertained, and consequently in arriving at an opinion as to the decrease of water supply the wells in and about London must be entirely excluded from the calculation. It appeared from the observations made, that occasionally when the waters were very low in the ground they might have a high flood, which was the case in 1821, when there was a high flood in the Thames while the water stored in the chalk in Kent was very low. In the present year (1885) the water in the Godstone Quarries had not risen at all. Such an occurrence was very rare, and showed that there was a considerable diminution in the quantity of water stored in the ground at the present time. The diagram embodied the results of observations extending over about three-quarters of a century, and was a fair period from which to draw a conclusion, but unfortunately there was a failure in the records between the years 1830 and 1835. It was desirable that these blanks should be filled in, and if any Fellow of the Society, or other person, had any gaugings or other observations that would throw light upon the subject extending over this or other periods, which they would communicate with the Committee, they would be conferring a great service in the endeavour to elucidate this question. The records showed that there appeared to be a recurrence of low water every ten years. There was lower water in 1824 and in 1835; the period 1844-5 was low, especially when compared with the years immediately before and following; 1854-5 was remarkably low also 1864-5, 1874-5, and now they came to the present low period of 1884-5. As to what was the cause of this marked periodicity it was very desirable to ascertain, and, having pointed it out, probably some light might be thrown upon the subject.

Mr. WHIPPLE said he was disappointed that no mention had been made of the extremely low state of the water in the Thames at Twickenham and Richmond during 1884. At low tide the river bed was drier than he ever remembered seeing it.

Mr. BALDWIN LATHAM said that with respect to the low state of the water in the Thames at Twickenham, about which so much had been said, the cause was not so much due to the diminution of upland water as to the increased range of the tide; the main channel having been deepened the tides rose much higher, and consequently fell much lower, than formerly. The upland flow of the river was very low last year, but there was evidence that it had been quite as low in former years.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT SAN PAULO, BRAZIL, 1879-1883. By the late HENRY B. JOYNER, M.Inst.C.E., F.R.Met.Soc. (Communicated by the President.)

[Read March 18th, 1885.]

THE observations were commenced on February 6th, 1879, and continued to the end of 1883. The pressures are reduced to 32°, but not to mean sea-level. The height of the cistern of the barometer was 2,393 feet above sea-level.

Occasional gaps in the observations of the direction of the wind and in the amount of cloud have been filled up with the probable readings, in order that the wind and weather summaries may be complete.

San Paulo is in lat. 23°·32′·53″ S, and long. 46°·36′·46″ W.

The results have been worked up and tabulated in the Meteorological Office.

1879.	Mean Pressure at 2,393 feet above sea level.	Air Temperature. 9 a.m.	Air Temperature. 9 p.m.	Air Temperature. Mean.	Means of Min.	Means of Max.	Absolute Min. and Max. Min.	Absolute Min. and Max. Date.	Absolute Min. and Max. Max.	Absolute Min. and Max. Date.	Tension of Vapour. 9 a.m.	Tension of Vapour. 9 p.m.	Tension of Vapour. Mean.
	Ins.	°	°	°	°	°	°		°		In.	In.	In.
January	..	..	..	..	..	..	..	..	..	..	..	..	..
February	..	70·8	67·7	..	63·0	80·6	55·1 ?	6	89·9?	6	·656	·627	..
March ..	..	68·6	66·2	67·4	60·3	80·0	45·0	29	86·4	20, 28	·591	·589	·580
April	..	63·7	61·1	62·4	55·7	75·5[1]	49·1	8, 11	83·9	15	·509	·502	·506
May	..	57·1	54·8[1]	56·0[1]	47·8	71·5	37·0	25	78·9	19	·415	·404[1]	·410[1]
June	..	52·7[1]	51·7[1]	52·2[2]	45·0	69·5[1]	30·0	17, 18	74·9	20, 26	·371[1]	·365[1]	·368[2]
July	..	54·4	53·1	53·8	45·1	74·3	35·0	28	81·9	31	·385	·377	·381
August ..	27·715	54·9	54·1	54·5	42·9	74·6[1]	30·0	11	85·9	4, 5, 6	·370	·380	·375
September	·661	58·3	55·9[1]	57·1[1]	47·3	73·5	26·1	9	86·9	28	·413	·420[1]	·417[1]
October ..	·627	64·9	60·2	62·6	52·7	79·1[1]	39·0	7	94·1	10	·491	·486	·489
November	·512	68·8	62·5	65·7	56·2	80·3	45·5	23	91·9	24	·538	·519	·529
December	27·485	71·5	66·6	69·1	62·2	81·1	53·1	4, 5	90·4	25	·613	·606	·610
1880.													
January	27·467	72·4	68·3	70·4	64·7	80·7	60·0	12	86·9	19	·662	·650	·656
February	·536	70·7	68·1	69·4	64·4	80·1	57·0	18	87·9	28	·638	·645	·642
March ..	·559	70·9	68·2	69·6	63·5	83·3	54·1	6	87·9	21	·652	·639	·646
April	·614	64·6	62·9	63·8	58·5	76·6	51·1	28	85·9	17	·546	·536	·541
May	·698	58·8	58·2	58·5	51·9	73·4	40·0	31	81·9	13, 17	·454	·453	·454
June ...	·752	54·6	54·1	54·4	46·5	70·2	31·0	30	80·9	13	·390	·389	·390
July	·669	57·7	57·5	57·6	49·4	72·8	35·0	1, 3	83·9	18	·430	·435	·433
August ..	·675	59·5	58·7	59·1	49·9	78·0	38·0	4	85·9	3, 29, 30	·447	·449	·448
September	·663[1]	63·0	60·3[1]	61·7[1]	56·8	73·8[1]	50·5	9	86·9	12	·515	·491[1]	·503[1]
October ..	·601[1]	63·2	60·3[1]	61·8[1]	54·5	74·6	42·0	18, 25	86·9	21, 31	·549	·518[1]	·534[1]
November	·579	69·2	64·4	66·8	59·2	79·1	48·1	4	88·9	15	·645	·596	·621
December	27·559[1]	71·0	65·8[1]	68·4[1]	61·3	80·8[1]	49·1	2	87·9	6, 17	·617	·588[1]	·603[1]
Year ..	27·614	64·6	62·2	63·4	56·7	77·0	..	..	..	..	·545	·532	·539
1881.													
January	27·513	71·7	68·3	70·0	63·1	81·9	50·1	30	88·9	31	·637	·628	·633
February	·507	69·1	66·5	67·8	62·2	79·8	54·1	28	88·9	1	·613	·598	·606
March ..	·556	68·4	66·4	67·4	61·5	80·1	55·1	1	88·9	1, 4	·623	·600	·612
April ...	·622[2]	63·1	62·7[2]	62·9[2]	56·2[2]	77·6	48·1	1, 11	83·9	27, 28	·518	·518[2]	·518[2]
May	·609[2]	59·1	57·8[2]	58·5[2]	52·0	73·7	34·0	28	83·9	8	·467	·435[2]	·451[2]
June ...	·723	56·5	56·0	56·3	49·9	71·6	38·0	28	79·9	5	·431	·425	·428
July	·739	54·4	53·6	54·0	47·0	70·8	39·0	10, 22	80·9	19	·386	·379	·383
August ..	·791[1]	55·5	54·8[1]	55·2[1]	47·3	71·8	37·5	11	81·9	13	·394	·393[1]	·394[1]
September	·692[1]	62·3[1]	60·9	61·6[1]	52·7	79·0	40·0	1	89·4	21	·489[1]	·481	·485[1]
October ..	·586	67·7	63·2	65·5	57·3	80·0	48·1	24	92·4	19	·544	·518	·531
November	·494	68·6	64·1	66·4	59·1	78·8[1]	49·1	23	90·4	4	·573	·547	·560
December	27·496	71·3	66·8	69·1	61·5	81·6	47·0	23	91·9	8	·626	·591	·609
Year ..	27·611	64·0	61·8	62·9	55·8	77·2	..	..	..	..	·525	·509	·517
1882.													
January	27·504	72·2	67·6	69·9	63·3	81·5[4]	55·5	19	90·9	2	·674	·635	·655
February	·523[1]	71·4	67·6[1]	69·5[1]	64·2[1]	80·3[2]	61·0	11, 22, 23	89·9	20	·665	·632[1]	·649[1]
March ..	·583	69·3[1]	65·7	67·5[1]	59·5	81·4	47·0	25	90·9	3, 5	·599[1]	·568	·584[1]
April	·649[1]	64·3	62·1	63·2	56·5	76·5	42·0	23	88·9	7	·531	·514	·523
May ..	·639	59·2[2]	58·0	58·6[2]	52·7[1]	74·2[1]	35·0	8	81·9	17, 18, 24	·457[2]	·454	·456[2]
June	·725	57·2	55·2	56·2	50·7	68·9	38·0	29	79·9	6	·437	·411	·424
July	·765	53·4	52·8	53·1	45·8	68·6	37·0	10	78·9	14, 15	·381	·382	·382
August ..	·770	58·6	55·2	56·9	46·3	75·2	33·0	7	83·9	28	·448	·430	·439
September	·662[1]	60·7	58·9[1]	59·8[1]	52·7	74·4	40·0	25, 30	86·9	7	·495	·491[1]	·493[1]
October ..	·604	66·1	61·0	63·6	54·1	77·9	41·5	25	90·4	2	·588	·532	·560
November	·537	68·8	61·9	65·4	54·3	78·7	43·0	18, 19	91·9	27	·634	·552	·593
December	27·516[2]	68·9[1]	63·0[2]	66·0[2]	57·1[1]	79·2[2]	43·5	18	89·9	18	·585[1]	·541[2]	·563[2]
Year ..	27·623	64·2	60·8	62·5	54·8	76·4	..	..	..	..	·541	·512	·527

[1] One Observation missing. [2] Two Observations missing.

Relative Humidity.			Amount of Cloud.			Rainfall.			Weather, No. of days of							Wind, No. of Observations of								
9 a.m.	9 p.m.	Mean.	9 a.m.	9 p.m.	Mean.	Total.	Max.	Date.	Rain.	Snow.	Hail.	Thunderstorms.	Clear Sky.	Overcast.	Gale.	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm.
o/o	o/o	o/o				Ins.	Ins.																	
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		..	..	..	..
87.0	92.6	..	7.7	6.0	..	8.13	**3.51**	**7**	13	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
84.7	91.6	88.2	6.8	7.6	7.2	3.69	1.36	3	13	0	0	6	2	15	0	8	5	9	7	3	2	0	4	24
86.3	93.1	89.7	7.3	5.4	6.4	3.46	1.47	2	12	0	0	4	1	9	0	3	6	2	2	5	0	0	4	38
88.9	94.0[1]	91.5[1]	7.0	5.1	6.1	1.20	0.54	5	6	0	0	1	3	10	0	3	1	2	5	0	0	0	2	49
93.0[1]	95.1[1]	94.1[2]	8.0	4.6	6.3	1.16	0.80	6	6	0	0	2	3	11	0	1	2	3	3	1	0	0	0	50
90.8	93.1	92.0	7.0	4.0	5.5	0.69	0.27	11	4	0	0	1	2	9	0	0	2	0	0	0	2	0	0	58
85.6	90.5	88.1	5.9	4.9	5.4	0.13	0.09	24	3	0	0	0	6	9	0	1	3	4	5	1	1	0	6	41
84.8	94.0[1]	89.4[1]	6.4	7.3	6.9	1.16	0.39	7	6	0	0	2	2	11	0	0	5	4	8	2	5	0	1	35
79.8	93.1	86.5	5.4	6.9	6.2	1.04	0.53	22	4	0	0	2	7	13	0	0	9	6	10	2	3	0	2	30
76.6	91.7	84.2	7.2	5.9	6.6	3.37	1.11	29	8	0	0	5	3	13	0	0	2	10	8	2	0	1	3	34
79.4	92.9	86.2	8.1	7.8	8.0	10.63	1.61	27	17	0	0	10	0	19	0	1	4	8	5	1	0	0	8	35
83.2	94.1	88.7	8.1	8.0	8.1	15.27	**3.01**	**6**	28	0	0	20	2	16	0	0	3	1	3	0	1	0	8	46
85.0	94.0	89.5	8 0	8.4	8.2	12.87	2.50	6	22	0	0	10	0	20	0	2	4	2	6	1	0	0	13	30
86.2	92.7	89.5	6.7	7.2	7.0	6.86	1.53	8	18	0	0	16	1	11	0	3	4	2	2	2	0	1	0	48
89.7	93.4	91.6	8.3	6.4	7.4	7.37	2.45	3	10	0	0	5	1	14	0	1	4	5	4	0	1	1	1	43
91.5	93.2	92.4	8.3	5.8	7.1	0.94	0.67	13	6	0	0	0	1	12	0	1	12	2	5	0	1	0	0	41
91.3	92.6	92.0	7.1	3.5	5.3	1.03	0.49	15	6	0	0	0	5	8	0	0	12	0	4	0	0	1	6	37
90.1	91.8	91.0	7.7	5.8	6.8	1.62	0.98	15	11	0	0	5	2	12	0	2	7	1	5	1	4	2	1	39
87.8	90.7	89.3	7.3	5.1	6.2	1.19	0.49	8	5	0	0	1	3	10	0	2	6	0	4	0	3	1	1	45
89.4	93.7[1]	91.6[1]	8.7	8.4	8.6	8.81	2.52	28	15	0	0	12	0	21	0	2	11	1	9	0	1	0	0	36
94.7	98.9[1]	96.8[1]	8.1	6.5	7.3	3.82	2.05	22	12	0	0	3	2	17	0	2	4	0	8	0	3	0	10	35
90.6	98.7	94.7	7.5	7.7	7.6	5.14	0.99	3	13	0	1	7	3	18	0	0	4	3	10	0	3	0	3	37
81.3	92.6[1]	87.0[1]	7.8	7.9	7.9	7.34	1.38	6	17	0	0	9	1	20	0	2	1	3	3	0	2	0	2	49
88.4	93.9	91.2	7.8	6.7	7.3	72.26	..	..	163	0	1	88	21	179	0	17	72	20	63	4	19	6	45	486
82.0	90.9	86.5	7.9	7.0	7.5	11.41	**2.61**	**8**	18	0	0	10	1	17	0	1	5	2	4	0	0	2	4	44
86.3	92.0	89.2	8.4	7.3	7.9	5.38	0.99	11	15	0	0	4	1	16	0	1	5	0	7	1	2	0	1	39
89.9	92.6	91.3	8.3	7.0	7.7	7.94	1.49	21	18	0	0	5	2	18	0	1	3	6	2	0	2	0	1	47
89.6	90.9[2]	90.3[2]	8.4	7.0	7.7	1.79	0.57	8	8	0	0	1	0	13	0	1	3	3	3	1	1	1	0	47
93.0	90.8[2]	91.9[2]	8.5	6.0	7.3	1.73	0.55	17	9	0	0	0	0	15	0	0	3	3	1	0	0	1	1	53
94.3	94.7	94.5	8.1	6.4	7.3	5.47	1.73	21	8	0	0	0	3	18	0	0	5	1	3	0	0	1	1	49
91.0	92.0	91.5	7.3	5.3	6.3	1.65	0.67	20	7	0	0	4	3	10	0	0	6	2	2	0	2	0	1	49
89.3	91.4[1]	90.4[1]	7.8	5.9	6.9	1.36	1.09	4	7	0	0	1	3	16	0	0	5	0	9	1	1	1	1	44
87.0[1]	89.9	88.5[1]	6.7	6.4	6.6	1.03	0.54	22	7	0	0	4	3	11	0	0	2	3	12	0	1	0	1	41
80.4	89.3	84.9	6.8	8.0	7.4	0.87	0.27	28	8	0	0	3	2	18	0	0	3	4	10	0	4	0	0	41
82.1	91.5	86.8	8.5	8.2	8.4	5.11	1.40	1	15	0	0	9	1	21	0	1	2	2	6	0	3	0	4	42
81.6	90.0	85.8	7.3	7.0	7.2	8.20	2.33	20	18	0	0	8	1	15	0	0	1	0	4	0	0	1	4	52
87.2	91.3	89.3	7.8	6.8	7.3	51.94	..	..	138	0	0	49	20	188	0	5	43	26	63	3	16	7	19	548
85.3	94.1	89.7	8.6	8.9	8.8	16.59	**2.61**	**4**	22	0	0	19	1	22	0	3	2	1	6	0	0	0	8	42
86.5	93.6[1]	90.1[1]	8.3	8.4	8.4	9.90	2.05	3	22	0	0	5	1	18	0	0	0	1	8	2	1	0	4	40
83.8[1]	89.9	86.9[1]	6.2	5.9	6.1	2.67	0.83	20	14	0	0	11	5	11	0	1	4	1	5	0	2	0	3	46
88.2	92.1	90.2	8.0	7.1	7.6	4.27	0.86	8	13	0	0	4	0	16	0	0	2	3	7	2	3	2	1	40
90.7[3]	94.2	92.5[3]	8 6	6.6	7.6	4.39	1.89	28	9	0	0	4	2	16	0	0	2	0	0	1	1	0	2	56
93.4	94.3	93.9	9.3	6.4	7.9	3.87	1.37	4	15	0	0	1	0	17	0	1	1	2	1	3	2	0	3	47
93.2	95.5	94.4	9.0	5.6	7.3	2.76	1.12	29	8	0	1	1	1	16	0	2	4	1	3	3	4	4	0	41
90.9	98.6	94.8	6.4	4.8	5.6	0.19	0.07	9	5	0	0	0	8	10	0	0	2	2	11	0	2	1	1	43
93.2	98.4[1]	95.8[1]	8.1	7.3	7.7	2.86	0.62	12	12	0	0	8	3	21	0	0	2	3	8	2	5	0	1	39
91.7	99.1	95.4	5.1	7.8	6.5	4.86	1.79	16	10	0	0	3	4	12	0	0	2	1	10	2	3	1	3	40
90.3	99.6	95.0	6.0	5.8	5.9	2.35	0.64	14	11	0	1	3	6	13	0	0	2	4	10	3	1	1	1	38
83.0[1]	93.9[2]	88.5[3]	7.6	6.5	7.1	5.69	1.67	7	15	0	0	5	4	15	0	1	2	2	8	1	0	1	7	40
89.2	95.3	92.3	7.6	6.8	7.2	60.40	..	..	156	0	2	64	35	187	0	8	25	21	77	19	24	10	34	512

[3] Three Observations missing. [4] Four Observations missing.

1883.	Mean Pressure at 2,393 feet above sea level.	Air Temperature.									Tension of Vapour.		
		9 a.m.	9 p.m.	Mean.	Means of		Absolute Min. and Max.				9 a.m.	9 p.m.	Mean.
					Min.	Max.	Min.	Date.	Max.	Date.			
..	In.	°	°	°	°	°	°		°		In.	In.	In.
January ..	27.533	70.0	66.8	68.4	59.9	81.8	45.0	1	89.9	5	.595	.587	.591
February	.531	70.6	67.6	69.1	63.2	81.8	58.0	5	88.9	25, 26, 27	.646	.629	.638
March ..	.581	69.5	67.9	68.7	61.9	83.8	56.1	5	89.9	22, 30, 31	.627	.622	.625
April	.616	63.7	61.7	62.7	55.2[1]	79.0	45.0	24, 29	88.9	3	.525	.516	.521
May	.674	57.9	56.6	57.3	50.5[2]	74.0[1]	38.0	26	84.9	12, 13	.451	.432	.442
June	.716	55.9	56.7	56.3	49.3	74.2	38.0	7	81.9	3	.414	.431	.423
July ...	.778	53.6	53.8	53.7	45.8[2]	73.3	33.0	28	84.9	29	.379	.381	.380
August ..	.754	54.4	53.4	53.9	45.6	69.7	28.0	19	87.9	25	.371	.373	.372
September	.703	59.8	58.3	59.1	51.8	74.4	40.0	23	84.9	12	.436	.440	.438
October ..	.595[3]	65.8	62.6[3]	64.2[3]	52.7	77.2[4]	37.5	23	89.9	2	.519	.522[3]	.521[3]
November	.554[5]	69.6[2]	64.4[4]	67.0[6]	59.6[3]	79.4[4]	48.5	5	88.9	23	.649[2]	.591[4]	.620[6]
December	27.565[4]	69.5	65.1[4]	67.3[4]	60.6	78.6	45.0	2	85.9	15	.665	.607[4]	.636[4]
Year ..	27.633	63.4	61.2	62.3	54.7	77.3	..	..	..	..	.523	.511	.517

[1] One Observation missing. [2] Two Observations missing. [3] Three Observations missing.

REPORT OF COMMITTEE ON THE OCCURRENCES OF THE HELM WIND OF CROSS FELL, CUMBERLAND, FROM 1871 TO 1884. (Plate VI.)

[Read April 15th, 1885.]

AT the Meeting of the Society on June 18th, 1884, a Paper was read by the Rev. J. Brunskill on "The Helm Wind."[1] The account of this phenomenon excited much interest; and the Council subsequently appointed a Committee to investigate the subject. The Committee considered it desirable, before recommending the establishment of a station with self-recording instruments on Cross Fell, that a circular letter should be inserted in the Penrith newspapers, calling attention to the subject, and inviting the contribution of records of past dates of Helm winds, and simple observations of various kinds in future. This was accordingly done, and the Committee has much pleasure in stating that a number of communications has been received in response to this appeal.

With the view of ascertaining as far as possible the meteorological conditions which exist when the Helm wind is blowing, all the recorded occurrences that have been received by the Committee have been chronologically arranged. The first systematic record commences in 1871, and in the present Report it is proposed to deal with all occurrences subsequent to that date until the end of 1884. Since that time more detailed records have been commenced at numerous stations in the locality, at the instigation of

[1] *Quarterly Journal*, Vol. X. p. 267.

Relative Humidity.			Amount of Cloud.			Rainfall.			Weather, No. of days of							Wind, No. of Observations of								
9 a.m.	9 p.m.	Mean.	9 a.m.	9 p.m.	Mean.	Total.	Max.	Date.	Rain.	Snow.	Hail.	Thunderstorms.	Clear Sky.	Overcast.	Gale.	N.	NE.	E.	SE.	S	SW.	W.	NW.	Calm.
o/o	o/o	o/o				Ins.	Ins.																	
81·2	89·3	85·3	6·9	7·3	7·1	16·50	6·00	26	20	0	0	11	3	14	0	1	2	3	6	2	0	0	6	42
86·2	93·2	89·7	8·6	8·1	8·4	6·64	1·55	4	22	0	0	17	0	19	0	0	1	2	5	0	1	1	3	43
87·1	91·2	89·2	7·3	5·6	6·5	6·05	2·33	19	13	0	0	7	4	12	0	1	1	4	4	1	3	3	2	43
89·0	93·8	91·4	7·6	7·6	7·6	3·69	1·07	3	15	0	0	7	3	19	0	0	1	1	1	0	3	1	1	52
94·0	94·1	94·1	8·5	4·4	6·5	3·48	1·44	13	8	0	0	5	3	11	0	0	1	2	3	0	2	1	4	49
92·6	93·7	93·2	8·5	5·0	6·8	1·28	0·28	29, 30	12	0	0	0	1	11	0	0	1	1	1	0	1	0	0	56
92·0	91·8	91·9	7·8	5·0	6·4	0·68	0·65	29	3	0	0	2	5	14	0	0	3	0	2	2	1	1	1	52
87·5	91·2	89·4	8·1	6·4	7·3	1·99	0·90	6	8	0	0	2	3	18	0	0	7	4	14	3	0	1	0	33
84·8	90·3	87·6	8·0	7·4	7·7	3·38	0·81	19	9	0	1	4	4	19	0	0	2	6	15	1	1	0	1	34
81·7	91·9[5]	86·8[5]	7·9	7·8	7·9	3·76	1·50	21	17	0	0	9	0	16	0	4	2	4	13	1	2	0	2	34
89·9[5]	97·8[4]	93·9[6]	8·1	8·9	8·5	4·63	1·18	12	16	0	0	8	2	23	0	2	2	2	3	1	3	1	4	42
92·4	98·1[4]	95·3[4]	8·5	9·1	8·8	8·41	2·44	3	22	0	0	9	1	23	0	0	0	6	6	2	2	0	8	38
88·2	93·0	90·6	8·0	6·9	7·5	60·49	..	..	165	0	1	81	29	199	0	8	23	35	73	13	19	9	32	518

[4] Five Observations missing. [5] Six Observations missing. [6] Seven Observations missing.

this Society, and with the active co-operation of Mr. T. G. Benn, of Newton Reigny, Penrith. The new material, which is of a much more extensive character, will it is hoped form the basis of a subsequent Report.

Ninety-three instances of the Helm wind were recorded from 1871 to 1884. For these records the Committee is indebted to Mr. Thomas Grierson of Cragside, Hutton Roof, Carnforth; Mr. T. Fawcett, Blencowe School, Penrith; Mr. W. Wallace, Battleborough, near Appleby; Mr. R. W. Crosby, Kirkby Thore; and Mr. J. Rennison, Kirkby Stephen.

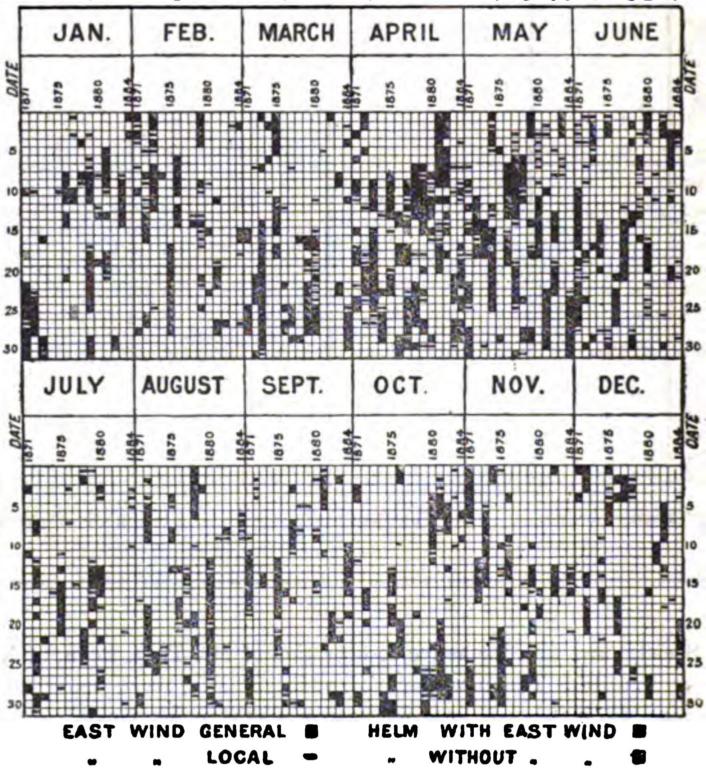
The occurrences for the several months were as follows:—

January ...	9	May	9	September ...	3
February ...	12	June	5	October	5
March	14	July	0	November	12
April	14	August ...	2	December	8

After collecting and tabulating all the known occurrences of the Helm wind, an examination was made of the atmospheric conditions existing in the locality, as well as generally over the whole country; and for this purpose a copy of the Daily Weather Chart for 8 a.m. was prepared for each day on which the Helm wind had been recorded.

These charts at once brought to light in the clearest possible manner the fact that, as a rule, whenever the Helm was on, or a Helm wind was blowing, there was an Easterly wind not only in the locality but generally over the entire country. (See Diagram, p. 228.)

DATES OF EAST WINDS AND HELM WINDS 1871-1884.



The following figures give the occurrences of the Helm wind for the several months when the general condition of the wind was not Easterly :—

January ...	8	May	0	September ...	0
February ...	0	June	0	October	0
March	1	July	0	November... ...	1
April	1	August	0	December	2

It will be seen that the exceptions to the general prevalence of Easterly winds were very few, and in all amount to only eight out of a total of ninety-three recorded Helm winds.

The different conditions of the Easterly wind with which the Helm occurs are very marked, indeed the Daily Weather Charts show that it occurs with winds having any Easterly direction from North-north-east to South-south-east, although it is most frequently observed with winds due East, or to the North of East, than with directions to the South of East. It also occurs with light as well as with strong winds, and occasionally the isobars show the existing difference of atmospheric pressure to have been exceedingly slight, and winds of the very lightest character to have prevailed.

The following details with respect to the general conditions of the weather which prevailed over the country at the time of the occurrence of the Helm wind, may be of interest as showing how widely these conditions differed. The cases chosen are merely typical of many others.

The prevailing condition. Gale.

1881, Jan. 18th. A general Easterly current prevailed over the United Kingdom, the lowest barometer (29·1 ins.) being situated over the English Channel. This was the occasion of the memorable storm over the southern parts of England, with heavy snowfall. (See Plate VI. Diagram 1.)

Ordinary wind force (moderate to fresh).

1875, Feb. 24th. North-easterly winds prevailed over the United Kingdom. An area of low pressure, 29·4 ins., was central over the south of England and the north of France. (See Plate VI. Diagram 2.)

1879, March 24th. Easterly winds were well established over the whole country. The barometer readings were highest over Norway, and lowest over France. (See Plate VI. Diagram 3.)

Light wind force.

1884, April 29th. The conditions were very quiet over England, light Easterly winds and calms prevailing. The ridge of maximum barometric pressure was situated near Cross Fell. (See Plate VI. Diagram 4.)

As the Helm wind seemed to occur so regularly with the Easterly wind, it was considered desirable to further extend the inquiry with regard to the East wind. The Daily Weather Charts were consequently examined for each day from January 1st, 1871, to December 31st, 1884, and every occurrence of East wind tabulated; the instances with general easterly conditions prevailing over the whole country being kept separate from those instances in which the Easterly wind was only partial, though of sufficient intensity to occasion the Helm wind. This examination showed that although the wind over the United Kingdom is generally Easterly when the Helm occurs, yet the Helm is not always observed whenever the wind is Easterly. Indeed, this step in the inquiry has not at all tended to the elucidation of the phenomenon in question, for it frequently happens that the conditions are to all appearances precisely similar to those existing when the Helm is on, and yet it did not appear. This may in part be due to the occasional failure to record the Helm, although it cannot possibly be in the main attributable to such an omission; but it points to other necessary conditions than absolute agreement of wind direction and isobaric lines. Possibly the different hygrometric qualities of the air with the existing Easterly winds may be an important factor in deciding whether or no the Helm will be formed, but it is not readily conceived why even in this case the Helm wind should not blow. It must, however, be borne in mind that the surface winds only can be examined, whilst those at a comparatively small elevation may be intimately connected with the phenomenon.

The following figures show the relative frequency of Easterly winds for each month for years 1871 to 1884;—

	Total No. of Days' Obns.	No. of Days with E wind.	Percentage do.		Total No. of Days' Obsns.	No. of Days with E wind.	Percentage. do.
January	484	81	19	July	484	67	15
February ...	396	84	21	August ...	434	85	20
March	484	100	23	September	420	79	19
April	420	184	44	October ...	484	85	20
May	434	149	34	November	420	89	22
June	420	117	28	December	484	66	15

It is possible to a certain extent to examine the different hygrometric conditions of the Easterly winds blowing at the surface, although at present the Committee has not extended the inquiry in this direction. From the observations made prior to those started at the beginning of 1885 no idea can be formed of the behaviour of the upper currents even at the time of the occurrence of the Helm winds, far less with the occurrence of each East wind experienced. The Society has, however, provided for the extension of the inquiry in this direction in the records which are now being collected, the observers supplying observations of the upper current by means of the clouds, as well as the direction of the winds at the surface of the earth.

As soon as a sufficient number of these observations has been received the Committee hopes to present a further Report upon the subject.

APPENDIX.

Notes and Extracts.

A very valuable record with respect to the Helm wind has been received from Mr. Thomas Grierson, of Crageside, Hutton Roof, Carnforth. The record contains extracts and draft sketches from his Diaries when residing in Scotland Road, Penrith. The sketches are instructive and interesting, but it is not possible to reproduce them in this Report.

The following brief extracts from Mr. Grierson's record will materially assist in a proper conception of the nature of a Helm wind :—

"The Helm wind, which is peculiar only to Cross Fell, a mountain fifteen miles east of Penrith, extends its wild influence to Penrith at times; at other times it is not so cold and piercing, and it is a common saying in Penrith—'The Helm is on, we shall have no good weather till the Helm is gone.' It often blows for days together from beneath the Cap, a white cloud like snow in the sunshine taking the shape of the mountain top, so much so that a stranger would fancy the mountain covered with snow,—as far as a black circle of dense clouds that often extends to the west of Penrith, and called the Helm Bar, beyond which 'bar' the Helm wind *never blows.*"

"June 2nd, 1873.—Heavy black clouds in the North, threatening thunder, but they gradually formed themselves into part of the Helm Bar that was hanging over the town. An old farmer near Culgaith never remembered the Helm wind being on in June but once before the present."

"April 8th, 1875.—A dark hazy cloud hanging over Penrith Beacon, and having a circle of clouds (a real Helm Bar) at some distance from it; this bar extending its radius as far as Greystoke, five miles from the Beacon, with a cold dry wind from the East and North-east. The steady cloud over the Beacon resembles a thunder cloud, having in the darker parts that blue colour that

thunder clouds have. All the rest of horizon bright and apparently cloudless. The wind is very strong and searching."

"April 27th, 1877.—It was beautiful to look on Cross Fell mountain (from neighbourhood of Moorhouses and Brougham Castle ruins, two or three miles South of Penrith), to see it capped with snow, the splendid white Helm cap of a cloud fitting the undulations of the mountain top, with the dark purple shadow of the mountain under it, the blue sky above, and a long white cloud between the 'Cap of the Helm,' hanging apparently along the line of the river Eden between oneself and the mountain—this long line of cloud being a 'burr' or bar to the Helm wind, and being immovable, and having been so for several days past, whilst a strong cold wind is blowing from the mountain towards Penrith, that is North-west."

Mr. Grierson had from time to time, prior to 1865, made experiments with small fire balloons and rockets during some of the Helm winds, but unfortunately his numerous memoranda and diaries containing detailed accounts have been lost.

The following is an account of the Helm wind observed on December 20th-21st, 1884, by Mr. J. Rennison, at Kirkby Stephen :—

"On Saturday the 20th, the Helm was blowing at 9 a.m. It was best defined over Hilbeck. The Bar was formed over Brough Sowerby and Musgrave. There was a portion of blue sky between the Helm cloud and the Bar, and on the North side of the Bar small clouds seemed to be formed. I do not know whether these clouds are formed in the open space between the Helm cloud and the Bar or not; but they always have the appearance of coming out of the blue, or being formed in the open space, when looked at from any place where I have made observations; and whenever or wherever the Bar is formed these small clouds are always being formed and driven into the Bar. On the day in question the Bar was well formed over Brough Sowerby and Musgraves or Langriggs; but lower down the valley the Bar was less dense, and opposite Roman Fell the Bar was nearly broken; but there was another Bar formed further South, suspended over Crosby Garrett and Kirkby Stephen, and small clouds were formed on the North side of it and driven into it. At 2 p.m. the Bar had melted away, except one end which was suspended over Stainmore, and small clouds were formed and driven into it.

"Sunday, on walking across to Crosby Garrett, about 1.30 p.m., I observed the Helm still blowing. I noticed the Bar was distinctly formed over Brough Sowerby, and the little clouds formed on the North of it. But there was no Helm cloud on the hills opposite. Before I reached Crosby a light cloud marked the place where the Helm cloud should have been. The Bar was again light and nearer the Fells lower down the valley, and small clouds were being formed and driven into a cloud South of the place where the Bar was nearly broken. On the South side of the Bar, where it was well formed, there seemed to be a steady breeze from the North, which tore clouds away from the Bar and drove them away southward. The clouds on the far South over Wild Boar Fell and the Ravenstonedale Hills were perfectly still."

Observations of the same Helm were also made by Mr. R. W. Crosby, of Kirkby Thore. The following is an extract from his Weather Register :—

"December 21st, Helm wind at night. Left Murton at 9 p.m. and rode towards the South-west, wind blowing from North-east, a fresh gale. At about one mile from the foot of the Fells passed into a dead calm, half a mile further met a gentle breeze from West-north-west, half a mile further found edge of Burr directly overhead, a little further the road turns at a right angle; rode from this point about four miles almost directly North-west, under the Burr all the way, and had a gentle breeze from West-north-west the whole time."

Mr. J. Rennison, of Kirkby Stephen, gives the following remarks :—

"Sometimes a Helm sets on the East; the Helm cloud being on by the Nine Standards, Tail Bridge, and Mallerstang Fell. This Helm is never so well defined as the one which sets along the Pennine Range by Cross Fell, but yet there are all the characteristics of the greater Helm, as there is the Helm cloud, the Bar, &c.; but it is shorter. The Helm cloud is not generally so smooth, neither is the Bar so well defined, and it seems more liable to cross-currents.

But the roaring of the wind is often very distinctly heard at Wharton, and sometimes at Kirkby Stephen Railway Station, but it is never quite calm under the Bar so far as I remember.

"On Sunday, December 28th, 1884, this East Helm was blowing, and I noticed the Helm cloud and the Bar with the small clouds being formed on the East side of the Bar and blown into it. About 5 p.m. the Bar was broken up, and I observed the clouds about the moon were blown across the face of the moon in various directions in less than five minutes. They were blown from East to West, from West to East, and from the South toward the North. On the 29th, the East Helm still seemed to be blowing, but owing to the state of the clouds I could make no definite observations."

Notes taken at Kirkby Thore, by Mr. R. W. Crosby, January 1885.

"January 15th.—The rushing of wind awoke me long before daylight, and on looking out I saw that the Helm was on. Made the usual observation at 9 a.m., found the North-east wind blowing strongly across the country, fresh gale, Helm cloud on Fells and broken Burr about half-a-mile south-west of the Eden light; clouds at a high elevation almost stationary, but with a slight tendency to drift from North-north-west. The wind soon after began to lull, and by noon the North-east edge of the Burr was directly over our house. Made another observation at 12.30, the Burr had advanced to within 1½ mile of the Fell foot; found the ground wind South-west, light breeze, the clouds overhead forming the Burr driving rapidly from the North-east, strong breeze, the high clouds above still maintaining their slight drift from North-north-west. In the afternoon took a walk to within half-a-mile of the Fell foot, found that the North-east wind disappeared about half-a-mile nearer the Fell than the edge of the Burr, but could not detect any sudden upward motion; it seemed to die away like the settling of a gust, but the driving of vapour into the Burr indicated that it was passing overhead. Examined the clouds carefully, the Helm cloud appeared to consist of a dense bank of vapour without motion, and lying at a considerable elevation above the Fell top; below this was an irregular bank of vapour lying close on the Fell top and extending some distance down the side, slightly agitated, and appearing to drift endwise in opposite directions from the neighbourhood of Cross Fell. By close watching I thought I could discern a process of evaporation going on and wasting away the South-west edge of this lower bank like the melting away of a cloud of steam.

"The Burr in this instance consisted of an upper and lower cloud, the upper very little agitated and drifting slowly from North-east, the lower very much agitated and driving rapidly in the same direction, but retaining its position by the constant accession of vapour on its North-east edge. It was most interesting to watch this operation, and the cloud being low there was a good opportunity to do so; evidently the clear space North-east of the Burr was charged with invisible vapour, which as it approached the Burr gradually condensed, and became thicker until it formed the dense lower cloud of the Burr. The lower cloud at this point was perhaps two miles in width from North-east to South-west, and at the South-west edge it melted and wasted away apparently by evaporation. The extent of the upper Burr cloud could not be seen without going in the opposite direction until one got fairly out from under the South-west edge of the lower cloud. So far as could be seen to-day the clouds which lay South-west of the Burr were on a higher level, and were quite stationary, at least they appeared so from here.

"January 16th.—This morning before sunrise the upper part of the Burr was near the Helm cloud, and nearly the whole space between was filled with vapours flying across from the Helm; dense near the Helm, thinner in the middle of the space, condensed again as they joined the Burr. The lower Burr cloud was broken and dispersed, there being some slight indications of it at a distance in the South-west, where a heavy bank of clouds was lying. A strong breeze blew from North-east right across the country under the upper Burr cloud all day until evening, when the lower cloud set again, and it was nearly calm at Kirkby Thore, while the roaring on the Fell could still be heard.

"January 17th.—During the night the wind had again broken loose across the country stronger in force, and some damage was done, a wheat stack being blown over, and a slate roof lifted at Street House, about one mile west of Bolton.

The general appearances to-day have been similar to those of yesterday, except that the wind was much stronger. As I write at 8 p.m. the Burr has set again near the Fell; we have but little wind here, a gentle breeze from South-east, but the Helm is blowing on the Fell."

Extract from a Letter received from Mr. W. WALLACE, of Battleborough, Appleby, dated December 15th, 1884.

"There is one phenomenon not often observed, connected with the Helm wind, which has come under my observation, and which may interest you.

"I came to reside at Dufton in 1861. Some time after that period Mr. John Ellwood, an elderly gentleman, who had resided at Dufton all his lifetime, informed me that he had occasionally seen the form of Dufton Pike reproduced in the clouds when the Helm wind was blowing. I resided in Dufton ten or eleven years, and I only remember seeing this cloud form once, respecting which I cannot now remember the date or particulars. During the last Spring, however, on observing indications of the Helm wind, I walked up the high ground of Appleby Fair Hill in order to have a good view of the storm clouds, and had the good fortune of seeing the form of the Pike reproduced in the sky. Apparently the cloud was projected upwards with great force from the summit of the Pike, almost colourless, and something like super-heated steam. It gradually expanded, grew darker, and assumed a slower motion as it flowed away from the Pike in a horizontal position. The Pike had the appearance of a burning mountain. It would be difficult for a gifted artist to reproduce in painting the weird appearance of the landscape under the clouds, and the leaden colour of the unclouded portion of the sky. I was kept spell-bound to the spot for a considerable time, during which no change took place in the form of clouds. The east side of the Pike is very steep, and though nearly all covered with verdure, very few people dare walk upon it. The Pike cloud flowed away at an elevation corresponding to the lower part of the Helm cloud. The clouds behind the Bar extend to the hills on the east side of Ullswater Lake. The Bar generally occupies a position near to the river Eden, though I have seen it much further west. It extends from Kirkby Stephen to the neighbourhood of Carlisle. As the Helm wind ceases, the unclouded portion of the sky between the Helm and Bar becomes filled with clouds.

"One of the greatest storms of Helm wind I ever experienced commenced on Sunday evening, April 1st, 1866, and attained its greatest force about six o'clock on the following morning. It unroofed our coach house and other outbuildings, with the exception of the stable. This wind extended to Appleby and unroofed a portion of St. Lawrence Church. It was reported that eight tons of lead was rolled off the roof. There was much damage done generally in the district.

"In the year 1860 I resided at Nenthead in the East of Cumberland. On Whit-Sunday evening, May 27th, the wind blew from the South-east and was intensely cold. During the walk from the church a friend remarked that it was cold enough for snow. Next morning there was lying over the whole country about four to six inches of snow. It had fallen from a still atmosphere, for it was not in the least degree drifted. The branches of the few trees growing at Nenthead were bent down with their load of snow. Such was the state of the weather in Alston Moor, and it may be taken for granted that it was not much different in the districts of the Upper Wear and Tees. From inquiries made after my removal into Westmoreland it appeared that the Helm wind commenced on the morning of the 28th, Whit-Monday. I have not been able to ascertain the exact hour. At Appleby between 3 and 4 a.m. there were two or three loud peals of thunder, and the snow which fell during the night was much drifted. On the Fell sides great numbers of sheep were deeply covered with snow, and before they could be found and extracted many of them were smothered. The sun melted the snow more rapidly than it does in the winter season. The loss to farmers was very serious. On Long Marton Moor the cattle taking shelter behind hedges or stone walls were covered with snow, with the exception of their heads. On Stainmoor the storm was very severe. A farmer who lived there at the time informs me that many of their ponies were overblown, and many sheep not covered with snow were frozen to death; in a few instances lambs were seen sucking the udders of their dead mothers. Many young geese, all huddled in heaps, were frozen to death.

"I left home on the last week of May to visit Middleton in Teesdale. I do not remember the year. The Helm wind was strong. When near to Warcop I perceived that it had levelled the stiches or rows in a field newly sown with turnips. The wind was blowing clouds of soil across the road, strongly smelling of guano, and continued strong until I crossed the summit of the mountain, and when I got into Lunedale there was only a moderate breeze. I remained in Teesdale until Friday, during my stay there the weather was cold and dry with a moderate Easterly wind. On my return home the country lying near the Fell side had a very blighted appearance, and I was informed that a very strong Helm wind had been in existence during nearly the whole period of my absence. I found my garden much blighted and many plants destroyed.

"I have given the above two instances of the state of the weather in the districts of the Upper Tyne and the Tees when the Helm winds were blowing strong in Westmoreland, under the impression they might interest you. The weather is generally cold with moderate breezes in the countries lying to the East of the Helm clouds; occasionally there is a still atmosphere. These facts are confirmed by experience.

"I remember one very striking instance which occurred towards the close of the Summer. The day had been very sultry and oppressively hot. In the evening I took a walk in the garden, when the Helm wind commenced to blow, as suddenly as if it had been set free by the opening of flood gates. The heated air in my garden was replaced in a few seconds by the cold Helm winds, and probably the whole of the atmosphere as far as Appleby in a few minutes. I often had to face these winds in my journeys on horseback to nearly the summit of the Cross Fell mountains. On the hillsides I felt it as a steady pressure or force without much variation of intensity. My impression is that if it were more gusty its destructive effects would be greater."

Newspaper Extract—author unknown.

The Helm Wind.

"Among the local disturbances in the tide of the atmospheric ocean, the Helm wind presents the most striking example in the British Isles. Its resistless violence, amidst comparative calm in the surrounding districts, its remarkable concomitants, and the frequency of its recurrence, have rendered it familiar to every one in its neighbourhood, called forth curiosity, and roused inquiry in the most rude and careless observer.

"The following explanation will, perhaps, prove satisfactory to our readers. In the first place it is to be observed that the Cross Fell mountain chain extends for several miles from North to South, at the distance of about sixty from the German Ocean, the highest summit reaching the height of 2,900 feet. The land may be considered to rise gradually, like a great inclined plane, till it reaches the above distance and height from the sea at Sunderland, Hartlepool, and Stockton, suddenly declining on the West, and forming a stupendous wall from North to South. Secondly, the Helm wind occurs only when the wind blows from the East or from an Easterly point; as soon as it crosses the ridge it thunders with irresistible impetuosity along the Western declivity and valley at the base, levelling every impediment in its course, as if it were an invisible avalanche. Nearly parallel with the summit of the mountain, but Westward, a heavy cloud hangs, known under the name of the Helm Bar. Immediately beyond the limits of the hurricane the air is peculiarly agitated with eddies and whirlwinds, and blows gently from the West towards the Bar, producing an opposite current.

In the next place it is to be recollected that warm air is capable of holding a much larger quantity of water in solution than cold,—that moist air is lighter than dry, and that warm air is lighter than cold,—and lastly, the higher we ascend a mountain the colder the air becomes.

To apply these facts to the Helm wind, let us suppose a breeze from the East leaves the sea on the east coast, of the temperature say of 60°,—is forced up the inclined plane by the volume of atmosphere from behind. It will consequently be reduced in temperature, and rendered incapable of holding the same quantity of water in solution, and therefore gradually deposit it in its course in the form of clouds, mist, rain or snow. From the reduction of temperature, say to 40°, and deposi-

tion of moisture, it will rush down the precipice like a cataract; as it descends it will receive heat, till at the foot of the mountain it again reaches say 60; its attraction for water being thus increased, it will absorb it. From the addition of heat and moisture becoming lighter it ascends, though, in consequence of the current from behind, it is prevented from returning up the mountain, again it has its temperature reduced, say to 50°, again deposits its moisture in the form of the cloud, the Helm Bar. The violent commotion within the more immediate limits must necessarily disturb and agitate the atmosphere in the vicinity, which will sufficiently account for the eddies, slight whirlwinds, and diverse courses of the wind.

"The above is necessarily only a very general statement of the phenomenon and its causes, our limits not permitting us to enter more fully into the explanation and illustration of the principles adverted to. At the same time those who have the desire and means of a more minute investigation of the theory here submitted will, we think, find it based upon principles which admit of demonstration, and that no unfair deduction has been hazarded from the facts."

The Helm Wind.

Extract from the *Penrith Herald*, April 28th, 1883.

"At the annual meeting of the Carlisle Scientific Society, held last week, Mr. F. Harrison read a paper on 'The Helm Wind.' He did not, he said, lay claim to much original information on the subject of the Helm wind, but he had collected from various sources the opinions and observations of some authorities of the past and present day on that very remarkable local phenomenon. The majestic Cross Fell in the eastern corner of Cumberland is the centre from which the Helm wind proceeds. It forms the highest point of the vast chain of mountains called the English Appennines, stretching right through the kingdom from the Tweed into Derbyshire, and is 3,000 feet above the level of the sea. This mountain used, according to tradition, to be called Fiends' Fell, from the terrible force of the storms that proceeded from it. One of the first individuals, so far as he knew, who paid any attention to the Helm wind, so far as regarded putting his observations into writing, was the Rev. Thomas Robinson, who was rector of Ousby in 1696. He was the author of a curious book entitled "This World of Matter, and this World of Light." Mr. Robinson describes the Helm. The Grand Helm, he says, is always opaque. The distance between helm and helm is called an arch, over which, as the vapours rise, the wind blows them from helm to helm until the stock be spent. The Grand Helm, he states, is all vapour, which causes the wind to be wet and rainy, and the arch overclouded. The second Helm is mixed, being part exhalation and part vapour. The third Helm is translucent, being all exhalations, the wind dry, and the air clear. The invisible Helms are all exhalations, and they seldom rise as high as the tops of the mountains, but fix upon waters, rivers, the sides of hills, &c. These winds are the lowest that blow, and one may go through them and find a calm on the tops of the mountains. Mr. Harrison then proceeded to describe the phenomenon as it might be witnessed from the high ground a little to the east of Long Meg when the Wind Helm was blowing with great fury. The towering summit of Cross Fell and all the lower points of that range might be seen covered with the Helm cloud, with the greatest apparent bulk stretching away to the south and north as far as the eye could reach. This vast cloud would be settled from the mountain summits down to the level of the villages at their base. The outside edge of this cloud is always of a bright appearance, although the bulk was a dark dense mass. One would not stand long until he observed that the bulk, formation, and every other feature of the Helm cloud was rapidly changing, and so it went on until it seemed to exhaust its forces. From where we are standing (continued Mr. Harrison) we can hear its roar like thunder. Although there is no wind at that spot, you can see the effects of its fury at no great distance. In yonder newly-sown field it is blowing away the dry soil in fearful clouds of dust. The reason it is calm where we are standing is because we are outside the Bar. This is the most singular part of the phenomenon. Often within a distance of 200 yards or less, should you be travelling towards the west from the fells, you can step out of a hurricane into the calm, outside the Bar. It is also a remarkable fact that the Helm wind

never blows on the east, or Alston side. It may be blowing with tremendous force at Melmerby, but at Alston, on the other side of the range of mountains, all is calm. The full force of the wind is felt in the country lying between the base of the mountain and the line of the Bar, which appears sometimes like a wall of barrier, in a parallel line to the Helm itself. Against the Bar the wind may sometimes be blowing from the West, but within the Bar the Helm may be blowing from the East with fearful velocity, causing great damage and destruction to the crops when they occur in the time of harvest. But the Helm is often felt with great fury without any appearance of the Bar at all. This is no doubt what Mr. Robinson called the Invisible Helm. When there is no Bar the wind extends further across the country, and gradually loses its force by mixing with contrary currents. Mr. Harrison went on to say that the Rev. J. Monahan of Appleby had furnished him with some valuable notes on the subject. That gentleman was of opinion that the Helm was caused entirely by the peculiar distribution of the land and the formation of the mountain range."

Extract from a Paper on the Helm Wind, by the late John Salkeld, Land Surveyor, Melmerby, near Penrith.

(Probably written about the year 1855.)

"Several expositions of the origin and causes of that singular phenomenon of nature, the Cross Fell Helm Wind, have been produced, yet none of them have appeared to me to be satisfactory throughout, inasmuch as they are either insufficiently supported by facts, or are, in some instances, at variance with the acknowledged laws of chemistry and hydrostatics; but as I have none of these productions at hand I must confess that I have only a partial recollection of their contents. I must, at the same time, allow that several of their conclusions appear to be just, and fully supported by the effect of this truly wonderful and variable phenomenon.

"I will here briefly mention what I consider to be its chief causes, after repeated observations and a uniform residence in the immediate vicinity of Cross Fell and his elevated yet huge and majestic compeers.

"The first thing that engages my attention is the formation of the Helm upon the brow of the mountain, extending from the summit of Cross Fell to the right and left, and generally as far as the range of mountains is of any considerable height. It is, however, in some cases more confined in its extent, yet invariably acknowledging the highest part of Cross Fell himself as its centre. And resting upon his towering summit with the greatest apparent bulk and condensation, the front of the Helm is generally clear and well defined, having, particularly at twilight, a very imposing and truly awful and majestic appearance. The loud noise or roaring of the wind as it were in the Helm previous to its rushing down the side of the mountain adds very much to the grandeur of the scene. The elements become confused, and a spectacle ensues which almost baffles description. Nothing can exceed the violence and impetuosity of some of those winds, causing great damage and destruction to the crops and property of the inhabitants.

"And yet they are often confined within from two to five miles from the foot of the mountain—this is the case when a cloud or Bar is formed in the air in a parallel direction to the Helm itself, the wind extending little further than the Bar; in fact it is met at that point by an opposite current of wind from the west. When there is no Bar the wind extends further across the country, and gradually loses its velocity; and mixing with contrary currents assumes a force and direction not at all connected with the mighty emporium from whence it proceeded.

"The Helm appears at various seasons of the year, and indeed at any season, as no man can form any idea at what particular time these winds will blow during the next year. The Helm wind, properly so called, has no connection whatever with the Siberian or Eastern winds, which are noted for their coldness. It is not dependent upon any current from the East, although it may sometimes be supplemented by a wind from that direction.

"The Helm has sometimes been formed, and a loud, roaring noise heard as it were in the Helm, and yet no strong current of wind has issued from it, but it

has gradually dispersed without blowing a hurricane. This must be attributed to the nature of the condensation, to the state of the atmosphere in different parts, and opposing and contrary currents of winds. All these and other circumstances contribute materially to alter this singular phenomenon; but it must, I think, be allowed that it is the peculiar formation of the Cross Fell chain connected with natural causes that effects its formation and completion.

"To those who have never witnessed its existence and effects, a view of it in its utmost grandeur presents a terrible and imposing scene.

"Cross Fell's extended and majestic crown, the inconceivable confusion and raging strife of the elements, the fearful velocity and gushing of the impetuous blast, and the utter perceivable insignificance of every thing that comes in contact with it, render it a sight at the same time truly awful and sublime."

THE HELM WIND.

Extract from the *Newcastle Daily Journal* and *Newcastle Courant*, January 1881.

"It is said by the people who live in the neighbourhood, that when the ordinary wind blows from the East, there prevails upon Cross Fell, the twin Dun Fells, and Hartside, a wind which in many respects is very unlike all ordinary winds. This peculiar wind is known by the name of 'The Helm,' so called, perhaps, because when it prevails, as it is said to do very often in spring and autumn, the summits of the mountains are hidden from view by a dense covering (helmet) of white mist. But beside the Helm wind and the helmet of mist, there is also the Helm Bar, a curious phenomenon, which is as curious in the manner of its formation as in itself. The wind is supposed to issue from the mist, and to carry portions of it a little way down the mountain side, where it forms them, if we may so speak, into a bell or band of mist, concentric with the outer edge of the helmet, and separated from it by a clear space. This bell appears to bar the further progress of the wind, and hence is called the 'Helm Bar.' But the Bar is observed to recede further and further down the mountain side, and to grow thinner and thinner as it recedes, until it is at last dispersed altogether. Then it is that the imprisoned wind rushes with great force into the valley beneath, dismantling hay-ricks and corn-stacks, uprooting trees, and, if report speaks truly, occasionally overturning both the farmer and his cart.

"The Helm prevails only when the ordinary wind is from the East; begins to blow somewhat suddenly after a fit, short or long, as the case may be, of calm weather, and is always accompanied by the appearance upon the mountains of the Helm cloud and the Helm Bar. Its force is greatest near, or actually upon the surface of the earth. Travellers who are caught by it upon the open moor, and seek shelter from its violence under the lee side of some hill, are astonished to find themselves exposed to its utmost fury in the very place where they supposed they should be protected from it; for, sweeping along the surface of the earth, it breaks over the escarpments of the hills and dips into the hollows like a flood of water. Its force seems to be spent before it reaches the banks of the Eden, a distance of about three or four miles from the foot of the mountains. Sometimes the Helm cloud gathers and the Helm wind begins to blow when the atmosphere in the valleys is calm and clear; but there is nothing peculiar in this circumstance, inasmuch as storms among the mountains are very common occurrences. The Helm wind is confined to a district some twelve or fifteen miles in diameter, of which Cross Fell forms the centre."

DISCUSSION.

Rev. J. AINSWORTH said there was one remark in the Report which he had particularly noticed, and that was that surface winds had only been observed while the upper currents might be intimately connected with the phenomenon. He thought this was very possibly the case, as where he had resided (about twenty miles west of Cross Fell) he had often observed when an East wind was blowing that the clouds were drifting from the West.

Mr. C. HARDING inquired of Mr. Ainsworth whether the 'helm' and 'bar' are connected by cloud towards their northern and southern margins, and if the sky

is generally clear in the space which intervenes between the 'helm' and the 'bar,' or only relatively clear in comparison with the denser clouds formed. He also stated that he had advanced a theory in explanation of the phenomenon, but as the Committee charged with the investigation are at present unwilling to commit themselves to it, he would not trouble the meeting with details, but would continue in the endeavour to establish or disprove it.

Rev. J. AINSWORTH said that the sky was quite clear between the 'bar' and Cross Fell as seen from the West.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT ASUNCION, PARAGUAY. By RICHARD STRACHAN, F.R.Met.Soc. (Communicated by R. H. Scott, F.R.S., Secretary to the Meteorological Council.)

[Read April 15th, 1885.]

THE observations now discussed were made at Asuncion, Paraguay, by Mr. C. A. Henderson, the British Consul, and were communicated to the Meteorological Office in 1860 by Sir Woodbine Parish.

No particulars are given regarding the instruments used, excepting that the barometer "was a very good one belonging to the Hon. Capt. Gore, late H.M.'s Chargé d'Affaires at Buenos Ayres." It would seem, however, from these results, compared with those of Lieut. Congreve's observations in 1874, that the barometer used by Mr. Henderson must have been more than 0·2 in. too low. The thermometer, showing the temperature of the air, was placed "under a shed, out of doors." Many observations were omitted, and interpolation had to be resorted to so as to get fair average values. Hence the results can only be regarded as approximately accurate. Nevertheless they appear to be of value, as they give a good general view of the meteorological character of a climate hitherto little described if known. The number of daily observations is more than is usually made by an unassisted observer, namely, four times during the first part, three times during the latter part, and five times daily during an intermediate period. Breaks in the continuity of the series were caused by the absence of the observer.

The direction and force of the wind and the state of the weather were roughly observed with frequent omission of one or the other.

From a discussion of the barometric observations it appears that the atmospheric pressure is much higher during the winter months, April to September, than it is during the summer months, October to March inclusive. The highest mean monthly pressure is in July, the lowest in December, and the difference is about a quarter of an inch.

Table I. contains the mean values of the observations on the temperature of the air. The monthly means derived from the whole series are as under :—

October ...	76·2°	April ...	73·3°
November ...	81·8	May... ...	67·6
December ...	81·9	June ...	68·8
January ...	87·3	July... ...	68·5
February ...	83·4	August ...	68·8
March ...	79·7	September ...	70·1
Summer ...	81·7	Winter ...	67·9

TABLE I.—MEAN TEMPERATURE OF THE AIR AT ASUNCION, PARAGUAY.

Month.	No. of Obs.	6 a.m.	7 a.m.	9 a.m.	Noon.	3 p.m.	6 p.m.	9 p.m.	Midnt.	Mean.
1855.										
January	—	° Not	° obser	° ved.	° —	° —	° —	° —	° —	° —
February............	26	74·4	—	—	89·3	—	82·9	—	77·2	80·9
March	29	76·0	—	—	86·2	—	81·7	—	77·5	80·4
April	26	67·9	—	—	82·7	—	77·4	—	69·9	74·5
May	24	67·2	—	—	77·8	—	72·5	—	68·7	71·6
June	30	58·2	—	—	69·4	—	64·3	—	60·7	63·1
July	31	57·9	—	—	70·6	—	65·3	—	61·3	63·8
August..............	25	64·7	—	—	76·4	—	71·6	—	66·8	69·9
September	20	68·3	—	—	77·3	—	73·4	—	68·1	71·8
October	26	69·9	—	—	78·2	—	75·9	—	69·7	73·4
November	30	74·1	—	—	85·1	89·5	84·4	—	77·6	80·3[3]
December	31	75·0	—	—	84·5	87·6	83·3	—	74·6	79·4[3]
Year[1]	—	69·4	—	—	80·8	—	76·8	—	71·2	74·6
1856.										
January	30	78·7	—	—	92·4	96·4	91·6	—	82·8	86·4[3]
February............	28	76·6	—	—	88·4	90·3	87·1	—	77·6	82·4[3]
March	31	74·2	—	—	84·3	86·0	81·2	—	75·3	78·7[3]
April	29	71·1	—	—	80·0	80·1	78·6	—	73·9	75·9[3]
May	29	—	—	—	66·9	69·4	64·2	—	61·4	65·5
June................	29	—	57·0	—	67·1	68·9	64·6	—	60·4	63·6
July	27	—	59·7	—	68·5	—	—	—	61·1	63·1
August..............	30	—	—	64·0	—	73·7	—	65·4	—	67·7
September	29	—	—	65·3	—	73·9	—	66·2	—	68·5
October	31	—	—	75·4	—	85·6	—	76·1	—	79·0
November	29	—	—	78·8	—	90·3	—	80·5	—	83·2
December	23	—	—	81·1	—	89·8	—	79·0	—	83·3
Year	—	—	—	—	—	81·2[2]	—	—	—	74·8
1857.										
January	31	—	—	84·7	—	95·0	—	84·9	—	88·2
February	26	—	—	84·4	—	92·2	—	84·0	—	86·9
March	29	—	—	78·8	—	84·0	—	77·2	—	80·0
April	30	—	—	67·5	—	74·6	—	66·1	—	69·4
May	29	—	—	63·6	—	70·8	—	63·1	—	65·8
June	24	—	—	62·1	—	68·5	—	63·3	—	64·6
November .... Mean date 24th	12	—	—	79·9	—	86·7	—	79·1	—	81·9
December	27	—	—	81·4	—	88·9	—	78·8	—	83·0

[1] Interpolating for January. [2] Interpolating for 3 p.m. July. [3] Omitting 3 p.m.

There is a gradual and considerable change of mean temperature from the colder to the warmer months. The mean for the year is 74°·8. The hottest month is January, 87°·8; the coolest July, 63°·5. There is a sudden check in the rise of temperature in December, which cannot be explained. The mean monthly temperatures are no doubt only approximately accurate, depending upon the error of the instrument and also upon the correction for diurnal range. The latter, however, cannot much exceed 1°, and would be subtractive. The former may be guessed at the same amount, and also subtractive. Hence these mean temperatures are possibly from 1° to 2° in excess of the true values.

The maxima heights of the barometer occur generally at 9 a.m. or noon,

TABLE II.—MONTHLY SUMMARIES OF THE WIND AND WEATHER AT ASUNCION, PARAGUAY.

Months.	Frequency of Winds.										Weather.		
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Variable.	No. of Obs.	Clear.	Rain.	Thunder-storms.
1855.													
January	9	4	4	3	4	—	—	—	6	30	13	7	4
February	3	5	3	8	2	—	—	1	6	28	13	6	2
March	11	4	2	3	2	—	—	1	8	31	12	11	10
April	7	3	2	4	1	—	1	2	7	27	11	6	3
May	7	12	4	3	2	—	—	—	1	29	21	2	1
June	7	5	3	6	5	—	—	—	4	30	9	6	1
July	5	11	4	4	5	—	—	—	2	31	11	4	1
August	6	5	2	2	6	2	—	1	2	26	9	5	2
September	4	2	—	3	4	1	1	1	4	20	7	6	4
October	5	3	1	2	4	3	1	—	7	26	13	9	5
November	5	4	—	1	4	4	1	—	11	30	13	9	4
December	4	5	2	2	9	2	1	—	6	31	13	10	9
Year	73	63	27	41	48	12	5	6	64	339	145	81	46
1856.													
January	5	9	2	1	3	1	—	1	9	31	17	3	3
February	1	6	—	1	6	2	—	1	12	29	9	11	6
March	1	6	3	1	5	2	—	—	13	31	8	10	5
April	5	10	2	—	4	4	—	1	4	30	8	10	3
May	2	7	—	1	9	5	1	—	6	31	6	6	2
June	4	12	1	2	6	1	1	—	3	30	17	6	2
July	2	15	4	1	4	2	—	—	3	31	18	3	3
August	2	11	1	2	9	1	—	—	5	31	13	3	2
September	1	12	1	2	7	2	—	—	5	30	9	12	6
October	3	13	2	—	4	3	—	—	6	31	17	7	4
November	3	10	2	3	4	1	—	—	6	29	7	4	2
December	1	8	2	3	5	—	1	—	11	31	15	7	7
Year	30	119	20	17	66	24	3	3	83	365	144	82	45
1857.													
January	3	13	2	2	3	1	—	—	7	31	12	4	3
February	8	7	1	—	4	—	—	—	8	28	9	7	5
March	2	10	3	2	8	1	—	—	5	31	8	11	4
April	2	5	4	5	13	—	—	—	1	30	11	4	2
May	—	12	5	6	3	2	—	—	3	31	16	3	2
June	—	13	8	2	4	2	—	—	1	30	15	7	3
July	—	11	6	2	7	1	1	—	3	31	8	7	2
August	1	7	7	3	10	—	—	—	3	31	11	10	3
September	1	6	1	5	7	2	—	—	8	30	9	9	6
October	3	7	4	3	7	—	—	—	7	31	6	12	7
November	1	11	—	2	9	1	—	—	6	30	15	7	3
December	1	8	5	2	5	—	—	—	8	29	15	10	6
Year	22	110	46	34	80	10	1	—	60	363	135	91	46

the minima at 8 p.m. With the high the weather was finer, clearer and colder than with the low barometers. The winds were generally Southerly with the high, and Northerly with the low barometers. The monthly range of pressure is greater in winter than in summer. The barometer attained its greatest height in July or August, that is in winter; its least in December,

January, or February, that is in summer; and the absolute range during the year is about 0·95 inch.

The maxima temperatures almost invariably occur with Northerly winds, the minima with Southerly, and the barometer is always lower with the former than with the latter. As regards the weather, it may be said that rain occurs more frequently with the minima temperatures than it does with the maxima. The absolute range of temperature during the year is about 60°. The least monthly range is 29° in March, and the greatest 44°·5, in July. The thermometer in the shade rose as high as 105° in January, and fell as low as 40° in July.

Table II. summarises the wind and weather observations of each month. It is at once seen that West and North-west winds are exceedingly uncommon. The prevalent winds are from North to North-east, and from South to South-east, and this seems to be general throughout the year. About 140 days in the year have clear weather; rain falls on about eighty-five days, and thunderstorms may be expected on forty-five days. Thunderstorms are common to all the months, but are most frequent in December, March, September, and October, summer months; these are also the months of the greatest number of rainy days.

An interesting account of the climate of Paraguay is given by Mr. Keith Johnston, in his "Notes on the Physical Geography of Paraguay," in the *Proceedings of the Royal Geographical Society*, Vol. XX.

DISCUSSION.

Mr. LAUGHTON asked Mr. Strachan if the tables which he had not read bore out Mr. Keith Johnston's statement that the Northerly and Southerly winds are in a nearly equal proportion throughout the year. His idea was that the Southerly winds are almost confined to the winter months, and are extremely rare at any other season of the year.

Mr. STRACHAN said that, as well as he could remember the data, neither the South nor North winds seemed to be confined to any particular season of the year, but they blew very much on a par, and were fairly distributed over the whole twelve months. Mr. Henderson's observations entirely confirmed Mr. Keith Johnston's description of the climate. The winds from West and North-west were very rare, and from South-east not much commoner.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

MARCH 18TH, 1885.

Ordinary Meeting.

ROBERT H. SCOTT, M.A., F.R.S., President, in the Chair.

RICHARD CHARLES HUNGERFORD PHELIPS, Cucklington, Wincanton; and
CAPT. ANTHONY STANDIDGE THOMSON, I.R.G.P. and Tel. Works Co., Silvertown, E.,
were balloted for and duly elected Fellows of the Society.

The following Papers were read, viz.:—

"THE MEASUREMENT OF SUNSHINE." By ROBERT H. SCOTT, M.A., F.R.S., President. (p. 205.)

"RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT SAN PAULO, BRAZIL, 1879-1883." By the late HENRY B. JOYNER, M.Inst.C.E., F.R.Met.Soc. (p. 223.)

The Meeting was then adjourned in order to afford the Fellows an opportunity of examining the following instruments which had been sent in for exhibition.

(N.B.—Engravings of several of the Instruments are given on Plates VII. and VIII.)

SIXTH ANNUAL EXHIBITION OF INSTRUMENTS.

SUNSHINE RECORDERS.

The first attempt at obtaining an instrumental record of the amount of sunshine was made by Mr. J. F. Campbell of Islay in the year 1854, when he mounted a hollow glass sphere filled with acidulated water in the centre of a cup of mahogany so arranged that the sun's rays were focussed on the inner surface of the cup and burned it.—The lines of burning therefore indicated the existence of sunshine.

Solid glass spheres were substituted for the hollow ones in 1857, and cards in metal frames (1875) have replaced the wood; but in its principle the sunshine recorder of 1885 differs little from that erected on Richmond Terrace, Whitehall, thirty years ago.

Other modes of recording sunshine are based on the action of the more actinic rays of the spectrum, instead of making use of the heat rays. Among workers in this direction may be mentioned Marchand of Fécamp, Sir Henry Roscoe and others. The most recent improvements in this direction are those by McLeod and by Jordan.

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1. **Campbell's Sunshine Bowls** (six), exhibiting the effect of sunshine during the half years:—June to December, 1855; December to June, 1856; June to December, 1856; June to December, 1883; December to June, 1884; June to December, 1884. (*See also No.* 58.)
Exhibited by the METEOROLOGICAL COUNCIL.

2. **Sunshine Recorder** for a fixed latitude. (*See fig.* 1, Plate VII.)
Exhibited by R. J. LECKY, F.R.Met.Soc.

3. **Universal Sunshine Recorder** with Stokes' zodiacal frame. (*See fig.* 2.)
Exhibited by R. J. LECKY, F.R.Met.Soc.

4. **Universal Sunshine Recorder,** with Stokes' zodiacal frame.
Exhibited by C. COPPOCK, F.R.Met.Soc.

5. **Sunshine Recorder** for a fixed latitude, as used by the Meteorological Office. *Exhibited by* C. COPPOCK, F.R.Met.Soc.

6. **Whipple-Casella Sunshine Recorder.**—The instrument is universal, having divided latitude and diurnal circles, and thus can be easily set for any locality, and for any day in the year. (*See fig.* 5.)
Exhibited by L. P. CASELLA, F.R.Met.Soc.

7. **Sunshine Recorder** with adjustments for use in any latitude. (*See fig.* 3.)
Exhibited by MESSRS. NEGRETTI AND ZAMBRA.

8. **Chemical Photometer devised by Sir H. Roscoe, F.R.S.**—This is a simple mode of measuring the chemical action of total daylight, adapted to the purpose of regular meteorological registration. By means of this instrument a strip of paper is so exposed that the different times of

chemical action can be calculated to within small fractions of a second. The exposure of the paper is effected simply by pasting pieces of standard sensitive paper upon a band, and inserting it into a thin metal slide having a small opening at the top furnished with a cover, which can be made instantly to open or close the hole under which the sensitive paper is placed. (First Pattern, 1863.)

Exhibited by THE KEW COMMITTEE.

9. **Jordan's Sunshine Recorder.**—This instrument consists of a dark cylindrical chamber, on the inner circumference of which is placed sensitised paper. The ray of sunlight, being admitted into this chamber through small apertures in the side, is received on the paper, and travels around it by virtue of the earth's rotation, leaving a distinct trace of chemical action, thereby registering its duration and the degrees of its intensity. The cylinder is mounted on a stand, with means of adjustment for the different seasons and for use in any latitude. The records obtained are rendered permanent by simply washing the papers for a few minutes in cold water and afterwards drying them between blotting-paper. (*See fig.* 6.)

Exhibited by Messrs. NEGRETTI AND ZAMBRA.

10. **Prof. McLeod's Sunshine Recorder.**—This instrument consists of a glass sphere silvered inside and placed before the lens of a camera, the axis of the instrument being placed parallel to the polar axis of the earth. The light from the sun is reflected from the globe, and some of it passing through the lens forms an image on a piece of prepared paper within the camera. In consequence of the rotation of the earth, the image describes the arc of a circle on the paper, and when the sun is obscured this arc is necessarily discontinuous. The image is not on a point, but a line, and in certain relative positions of the sphere, lens and paper, the line is radial and very thin, so that the obscuration of the sun for only one minute is indicated by a weakening of the image. (*See fig.* 4.) *Exhibited by* J. J. HICKS, F.R.Met.Soc.

SOLAR RADIATION THERMOMETERS.

The successive stages in the assumed perfecting of this instrument have been as follows :—An ordinary mercurial thermometer acts as a spherical mirror, and reflects the rays which fall upon it. To lessen this the bulbs were first made with black glass ; moreover, originally the degree marks were put upon the supporting slab, then they were put upon the tubes of the thermometers.

It was afterwards found that in a position where two thermometers with similarly coated bulbs were placed in the sunshine, but one was exposed to more wind than the other, the indicated temperatures varied greatly. To avoid this it was proposed that the thermometer should be inserted in a glass envelope exhausted of air. Various forms of mounting have been adopted, but the chief efforts have been expended in determining the influence of the amount of air left in the so-called vacuum. The next stage was, that inasmuch as black glass had a bright surface there was still much heat reflected, and therefore the surface was dulled with a coat of lamp black—so that all heat falling upon the bulb might be absorbed. Subsequently, owing to the influence of the lower temperature of the unblackened thermometer tube, about 1 in. of it was coated like the bulb.

As evidence of the degree of exhaustion, a small mercurial pressure gauge was attached to the thermometer, and by other makers platinum wires were soldered through the shield so that the stratification of the electric arc might indicate the amount of air still left.

11. **Black-glass bulb Maximum Thermometer** on boxwood scale (not divided on stem). Negretti, No. 445. Made previous to 1856.

Exhibited by the METEOROLOGICAL COUNCIL.

12. **Black glass bulb Maximum Thermometer.**
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

13. **Black-glass bulb Maximum Thermometer** divided on stem. Negretti, No. 1969 (1862). *Exhibited by the* METEOROLOGICAL COUNCIL.

14. **Black-glass bulb Maximum Thermometer** *in vacuo*, with cork bearing. Correction by Kew Standard Black-bulb at 140° in sunshine + 19°·7. (*See fig.* 7.)
Exhibited by the METEOROLOGICAL COUNCIL.

15. **Black-bulb Maximum Thermometer** *in vacuo*.
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

16. **Black-bulb Maximum Thermometer** *in vacuo*, used by Rev. F. W. Stow as a standard in his Solar Radiation investigations. This was the first instrument made *with the stem blackened.* (*Quart. Journ.* Vol. II. p. 206.) *Exhibited by the* ROYAL METEOROLOGICAL SOCIETY.

17. **Hicks's Black-bulb Maximum Thermometer** *in vacuo*, with platinum wires and battery for testing the vacuum. (*See fig.* 9.)
Exhibited by J. J. HICKS, F.R.Met.Soc.

18. **Bright-bulb Maximum Thermometer** *in vacuo*, with platinum wires. Hicks, No. 37 (1875). Difference from black-bulb *in vacuo* at 110° in sunshine + 38°·5. *Exhibited by the* METEOROLOGICAL COUNCIL.

19. **Negretti and Zambra's Black-bulb Maximum Thermometer** *in vacuo*, with mercurial test gauge. (*See fig.* 8.)
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

20. **Hicks's Radio-Solar Thermometer.** This is the ordinary Black-bulb Maximum Thermometer *in vacuo*, but having at the end of the outer jacket a second chamber in which is mounted vertically one of Crookes's radiometers for testing the vacuum. (*See fig.* 14.)
Exhibited by J. J. HICKS, F.R.Met.Soc.

21. **Southall's Helio-Pyrometer** for testing the accumulated heat of the sun in a confined blackened space, under glass. A black-bulb maximum thermometer is fixed on a cushion at the bottom of a box, the sides of which are also cushioned, and a thick piece of plate-glass is laid upon the top to prevent currents of air carrying off the heat, also with the view of preventing the cooling effects of terrestrial radiation. The box is placed in such a position that the sun's rays may fall as nearly as possible perpendicularly on the glass. A small vessel is also added in which water boils violently in the box, a piece of tube carrying off the steam.
Exhibited by L. P. CASELLA, F.R.Met.Soc.

22. **Bourke's Modified Solar Thermometer.** — This consists of an ordinary maximum thermometer *in vacuo*, which has only that half of the bulb blackened on which the sun's rays fall. The portion of the interior surface of the outer jacket which is turned towards the sun is coated in the same way. The whole is embedded in cotton wool, and placed in a box, the surfaces of which are of a dull black.
Exhibited by Capt. E. BOURKE, F.R.Met.Soc.

23. **Negretti and Zambra's Black-bulb Maximum Thermometer** *in vacuo*, for exposure to the sky in a vertical position. The scale is figured in the opposite way to an ordinary instrument, the reading commencing from the end of the tube and not at the bulb.
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

24. **Black-bulb Maximum Thermometer** *in vacuo*, with metallic fastenings (Casella, No. 9182). *Exhibited by* G. J. SYMONS, F.R.S., F.R.Met.Soc.

25. **Black-bulb Maximum Thermometer** *in vacuo*, with a very small bulb, and having the bore magnified about twelve times by the tube being made in the form of a lens, *Exhibited by* J. J. HICKS, F.R.Met.Soc.

26. **Black and Bright-bulb Maximum Thermometers** *in vacuo*, with stand. for mounting the same. *Exhibited by* L. P. CASELLA, F.R.Met.Soc.

27. **Black and Bright-bulb Thermometers** *in vacuo*, upright for hourly readings. (As used at the Montsouris Observatory, Paris.) *Exhibited by* G. J. SYMONS, F.R.S., F.R.Met.Soc.

28. **Black-bulb Maximum Thermometer,** in dry air, formerly one of Mr. Nunes's experimental series. (See *Meteorological Magazine*, Vol. V. p. 169.) *Exhibited by* G. J. SYMONS, F.R.S., F.R.Met.Soc.

29. **Frankland's Self-registering Differential Solar Thermometer,** for recording the maximum solar intensity during a day or any other period. *Exhibited by* L. P. CASELLA, F.R.Met.Soc.

30. **Three Thermometers,** with the bulbs inserted in hollow copper balls, for indicating the amount of heat radiated by the sun. *Exhibited by* W. F. STANLEY, F.R.Met.Soc.

31. **Experimental Black-bulb Maximum Thermometers** *in vacuo*, and apparatus for comparing the same with the heat radiated from an Argand gas burner. *Exhibited by* THE KEW COMMITTEE.

32. **Black-bulb Maximum Thermometer** *in vacuo*, in which the bulb was broken by the hailstorm of August 3rd, 1879, without injury to the outer jacket. *Exhibited by* THE KEW COMMITTEE.

ACTINOMETERS, &c.

33. **Herschel's Actinometer,** for ascertaining the absolute heating effect of the solar rays, in which time is considered one of the elements of observation. The actinometer consists of a large cylindrical thermometer bulb, with a scale considerably lengthened, so that minute changes may be easily seen. The bulb is of transparent glass filled with a deep blue liquid, which is expanded when the rays of the sun fall on the bulb. When taking an observation, the actinometer is placed in the shade for one minute and read off; it is then exposed for one minute to sunshine, and its indication recorded; it is finally restored to the shade, and its reading again noted. The mean of the two readings in the shade, subtracted from that in the sun, indicates the amount of expansion of the liquid produced by the sun's rays in one minute of time. (*See fig.* 11.) *Exhibited by* THE KEW COMMITTEE.

34. **Hodgkinson's Actinometer.** This instrument consists of a thermometer with a spherical bulb one inch in diameter, and a tube, of which an inch and a half next the bulb is left undivided. The fluid employed is alcohol coloured with a drop of pure aniline blue. The principle of the instrument is the same as that of Sir J. Herschel's. It was devised for mountain use, where the weight of the Herschel and the fragility of its internal thermometer are elements of difficulty. A plain telescope tube of bright metal 18 ins. long and 2½ ins. in diameter, open at both ends, is pierced in its central section with a circular hole 1¼ to 1½ in. in diameter, from which springs a flanged shoulder projecting about ½ in. to receive a perforated split bung, which clasps the thermometer stem and holds the bulb firmly in the centre of the axis of the tube. Two caps, fitted at the ends with clean plate glass, are made to slide off and on at the two ends to admit of the glasses being readily wiped. (*Proc. Roy. Soc.* Vol. XV. p. 321.) *Exhibited by* THE KEW COMMITTEE.

35. **Pouillet's Direct Pyrheliometer.** This instrument is composed of a shallow cylinder of steel, A, which is filled with mercury. Into the cylinder a thermometer, D, is introduced, the stem of which is protected by a piece of brass tubing. As the surface, B, on which the sun's rays fall and the quantity of mercury within the cylinder are both known, the effect of the sun's heat upon a given area can be expressed by stating that it is competent in five minutes to raise so much mercury so many degrees in temperature. (*See fig.* 12.) *Exhibited by* THE KEW COMMITTEE.

36. **Secchi's Solar Intensity Apparatus** for measuring the comparative heat of the sun's rays. Two thermometers are kept immersed in a fluid at any convenient temperature, and a third, surrounded by the same conditions, but not immersed, is exposed to the rays of the sun. The increase of temperature thus obtained is found to be the same, irrespective of the temperature of the fluid which surrounds it.
Exhibited by L. P. CASELLA, F.R.Met.Soc.

37. **Crookes's Radiometer.** This instrument consists of four arms of some light material, suspended on a hard steel point, resting in a jewel cap, so that the arms are able to revolve horizontally upon the centre pivot. To the extremity of each arm is fixed a thin disc of pith, white on one side and lamp-blacked on the other, the black surfaces of all the discs facing the same way. The whole is enclosed in a thin glass globe, which is then exhausted to the highest attainable point and hermetically sealed. The arms rotate with more or less velocity under the action of radiation. *Exhibited by* J. J. HICKS, F.R.Met.Soc.

38. **Winstanley's Radiograph** consists of a modification of a Leslie's differential air thermometer, one bulb being blackened and the other left clear. The expansion of the air in the blackened bulb causes an alteration in the balance of the instrument, thereby moving a registering index. (Engravings of two patterns of this instrument were exhibited, see No. 73.) *Exhibited by* THE KEW COMMITTEE.

TERRESTRIAL RADIATION THERMOMETERS.

The pattern of minimum thermometer used for measuring terrestrial radiation has varied very little. The Rutherford minimum has almost always been used, but its sensitiveness has gradually been increased; the spherical bulb was replaced by a cylinder, the cylinder was elongated and bifurcated, and eventually, in order to strengthen the forks, they were united into what is known as a "link."

Another plan was to flatten the cylindrical bulb into as thin a plate as possible, this giving a maximum of surface in proportion to the contents.

The bulb was also made double, and thus we have the so-called "bottle" pattern, and then the tube was led into the side of the bottle, and both ends of the bottle were left open, and so we have the "open cylinder"—a remarkable specimen of glass blowing.

Then there have been two patterns of mercurial thermometers, Casella's and Negretti's.

Difficulties have arisen from the degree marks being obliterated by the weather. To guard against this, the tube has been enclosed in what are known as Leach's shields, and many attempts have been made to render the joint at the entrance of the tube watertight. This is not easy, because the thermometer is exposed to a great range of temperature, and the air inside the shield varies so much in volume that it forces its way through almost every joint. The object is, however, effected when the external jacket is sealed on the stem near the bulb,

39. **Black-glass bulb Minimum Thermometer.**
Exhibited by L. P. CASELLA, F.R.Met.Soc.

40. **Minimum Thermometer,** with parabolic metallic reflector. (*See fig.* 21.)
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

41. **Casella's Mercurial Minimum Thermometer.** At a short distance from the bulb a small bent tube with a large bore, *d*, joins the indicating tube. At the upper end of this bent tube there is a flat glass diaphragm *b*, which is formed by the abrupt junction of a small chamber, *a*, the inlet to which is larger than the bore of the indicating tube. The result of this is, that on the thermometer being set, the contractile force of the mercury in cooling withdraws the fluid in the indicating stem only, whilst on its expanding with heat, the long column does not move, the increased bulk of mercury finding an easier passage through the larger bore into the small pear-shaped chamber attached. (*See fig.* 16.)
Exhibited by L. P. CASELLA, F.R.Met.Soc.

42. **Negretti and Zambra's Mercurial Minimum Thermometer.** A small vertical tube, B, is connected with the indicating tube at right angles, about one inch from the bulb; in this tube is inserted a platinum plug, C. On a decrease of temperature the mercury falls in the large tube until it attains its minimum; and on an increase of temperature, the mercury rises in the small tube, leaving the indicating column in the large tube registering the minimum temperature. (*See fig.* 18.)
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

43. **Bifurcated Minimum Thermometer** on ebonite. (*See fig.* 17.)
Exhibited by L. P. CASELLA, F.R.Met.Soc.

44. **Hicks's Bottle-Bulb Minimum Thermometer.**
Exhibited by J. J. HICKS, F.R.Met.Soc.

45. **Hicks's Hollow-Cylinder Minimum Thermometer.** (*See fig.* 23.)
Exhibited by J. J. HICKS, F.R.Met.Soc.

46. **Minimum Thermometer,** with flat bulb.
Exhibited by S. G. DENTON, F.R.Met.Soc.

47. **Hicks's Minimum Thermometer** with ground joint to exclude moisture.
Exhibited by J. J. HICKS, F.R.Met.Soc.

48. **Negretti and Zambra's 'Link-shaped' bulb Minimum Thermometer.** (*See fig.* 22.) *Exhibited by* Messrs. NEGRETTI AND ZAMBRA.

49. **Negretti and Zambra's Inverted Minimum Thermometer.**
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

50. **Minimum Thermometer** with external protecting tube hermetically sealed to stem. *Exhibited by* J. J. HICKS, F.R.Met.Soc.

51. **Set of Minimum Thermometers** illustrative of degrees of sensitiveness. (*Quarterly Journal*, Vol. II. p. 123.)
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

52. **Bourke's modified Terrestrial Radiation Thermometer.** This arrangement is designed with the intention of avoiding the disturbing influence of earth temperature upon the indication of terrestrial radiation thermometers. A radiation thermometer indicates the sum of the effect of radiation temperature on its upper surface, and of the temperature of the earth and grass beneath it, upon its lower surface. Capt. Bourke having noticed that the bulbs of Solar Radiation vacuum thermometers are often ice-coated when no hoar frost is on an ordinary terrestrial radiation thermometer, has in this instrument combined parts of each, and by completely surrounding the lower half of the thermometer by non-conducting media has largely reduced what may be called the soil influence.
Exhibited by Capt. E. BOURKE, F.R.Met.Soc.

53 **Leslie's Ætherioscope.**—This consists of two glass bulbs united by a vertical glass tube, of so fine a bore that a little coloured liquid is supported in it by its own adhesion, there being air confined in each of the bulbs. The lower bulb, A, is enclosed in a highly polished brass sphere, D. The upper bulb, B, is blackened, and placed in the centre of a metallic cup, C, which is gilt on the inside, and may be covered by a top, F. When the top is on, the liquid remains at the zero of the scale. On removing the top and presenting the instrument to a clear sky, either by night or by day, the upper bulb is cooled by terrestrial radiation, while the lower bulb retains the temperature of the air. The air confined in the upper bulb therefore contracts, and the elasticity of that in the lower bulb forces the liquid up the tube to a height proportionate to the intensity of the radiation. (*See fig.* 20.)

Exhibited by Messrs. NEGRETTI AND ZAMBRA.

NEW INSTRUMENTS.

54. **Hicks's "One Minute" Clinical Thermometer.**

Exhibited by J. J. HICKS, F.R.Met.Soc.

55. **Opaque Thermometer, Rain-gauge Jars, and other Measures.**—These instruments are surrounded by a strip of white enamel extending all round the back and sides of the tubing except along a narrow space of clear glass forming the correct line of sight through which the bore is viewed, and have the divisions and figures engraved at the side of this narrow space over the white enamel.

Exhibited by J. J. HICKS, F.R.Met.Soc.

56. **Davis's Self-timing Anemometer,** for recording the velocity of the air in mines, furnaces, &c. The indications are so expressed that the use of a watch may be dispensed with. *Exhibited by* Messrs. JOHN DAVIS & SON.

57. **Meteorologist's Wind Vane or Anemoscope.** (*See p.* 64.)

Exhibited by G. M. WHIPPLE, B.Sc., F.R.Met.Soc.

DIAGRAMS, PHOTOGRAPHS, &c.

58. **Diagrams illustrating the Sun's Burning Power by Campbell's registering Sun-dial** at the General Board of Health, Whitehall, from December 21st, 1854, to June 21st, 1856. (*Return on Warming and Ventilation of Dwellings* 1857.)

Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

59. **Photograph showing Diminution of Intensity of Actinic Action during the Solar Eclipse of July 18th, 1860.**—This record was obtained by sensitising a large sheet of paper, and covering it with a thick slab of brown paper with a slit in it. The slit allowed the light to reach one portion only of the sensitised paper. At the end of each 5 minutes the cover was moved the breadth of the slit and a fresh portion of the sensitised paper was exposed. After the eclipse the whole was fixed, and the photograph shown was taken so as to reduce the size. (See Symons *On the Solar Eclipse of July 18th,* 1860."

Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

60. **Records from Prof. McLeod's Sunshine Recorder.**

Exhibited by PROF. H. MCLEOD, F.R.S.

61. **Twelve Diagrams showing the Monthly Percentage Values** of the possible Duration of Sunshine in the British Isles, mostly for the period 1881-4. *Exhibited by* R. H. SCOTT, F.R.S., Pres.R.Met.Soc.

62. **Diagrams showing Sunshine Results at Geldeston,** Norfolk, 1881-1884. *Exhibited by* E. T. DOWSON, F.R.Met.Soc.

63. **Volume of graphic Record of Sunshine at Aspley Guise** for the four years 1881-1884. *Exhibited by* E. E. DYMOND, F.R.Met.Soc.

64. **Graphic Register of Sunshine** recorded at Strelley, Notts, showing the total duration, the percentage of possible duration, and the actual time at which the sun shone on every day from March 1st, 1881, to March 10th, 1885. Also from March 1881 to December 1883, giving the total duration of Sunshine during each hour for the whole month. *Exhibited by* T. L. K. EDGE, F.R.Met.Soc.

65. **Diagram comparing the Sunshine** at Strelley with that recorded at Hodsock, distant 27 miles. This shows the mean hourly duration for each of the ten months, March to December—calculated from the three years, 1881-83. The most sunny hour of the day at each station for each month is at once seen, and it will be observed that although at Strelley the sun generally shines less in the morning than at Hodsock, at the former station for some hours before sunset there is invariably an excess of sunshine over the low stations. *Exhibited by* T. L. K. EDGE, F.R.Met.Soc.

66. **Diagram similar to the above,** giving the results for the six months, April to September, together; on this the excess at Strelley in the late afternoon is strongly marked. *Exhibited by* T. L. K. EDGE, F.R.Met.Soc.

67. **Tables** from which the above diagrams were compiled, showing the duration of Sunshine during each hour of every month from March 1881 to December 1883, and the mean duration for each hour. *Exhibited by* T. L. K. EDGE, F.R.Met.Soc.

68. **Records for the days on which the greatest duration of Sunshine** was recorded at Strelley in the years 1881-84. *Exhibited by* T. L. K. EDGE, F.R.Met.Soc.

69. **Engraving and Description of Dr. D. Draper's Self-Recording Sun Thermometer,** as in use at the New York Meteorological Observatory. *Exhibited by* THE ROYAL METEOROLOGICAL SOCIETY.

70. **Engraving of Richard's continuously recording Black and Bright Bulb Solar Radiation Thermometers.**—This is a modification of Richard's well-known thermograph, and gives a continuous ink record of the temperature of a black and a bright bulb thermometer in vacuum envelopes. *Exhibited by* G. J. SYMONS, F.R.S., F.R.Met.Soc.

71. **Photograph showing experimental Solar Radiation Thermometers** in position at Heathfield Lodge, Chislehurst. *Exhibited by* G. J. SYMONS, F.R.S., F.R.Met.Soc.

72. **Photograph of Prof. Balfour Stewart's Actinometer.** *Exhibited by* THE KEW COMMITTEE.

73. **Engravings of two patterns of Winstanley's Radiograph.** (See *Photographic News*, March 18th, 1881.) *Exhibited by* G. J. SYMONS, F.R.S., F.R.Met.Soc.

74. **Four Photographs of Cloud Views** taken from the summit of Mount Hamilton, California, December 1882. Also photograph of the Lick Observatory, 4,250 feet above sea-level, Mount Hamilton, California, 1882. *Exhibited by* Prof. D. P. TODD.

75. **Seven Photographs of Clouds** taken by Mr. G. W. Ormerod, F.R.Met.Soc. at Teignmouth. *Exhibited by* W. MARRIOTT, F.R.Met.Soc.

76. **Set of Photographs of Clouds** taken simultaneously by two photographic cameras (photo-nephoscopes) 800 yards apart, but electrically connected. These were taken with the object of determining the altitudes of clouds. *Exhibited by* THE KEW COMMITTEE.

77. **The Chromatics of the Sky.**—Third series of Chromatic sketches of clouds and other atmospheric phenomena, taken with the object of assisting in making weather forecasts, 1884-1885.
Exhibited by J. S. DYASON, F.R.Met.Soc.

78. **Photograph of Flash of Lightning** taken by Dr. Puddicombe, R.N., on board H.M.S. *Neptune*, at 6.30 p.m. on November 14th, 1884, on a voyage from Madeira to Gibraltar. The flash was followed in three seconds by a loud clap of thunder. The evening was perfectly dark and rain fell heavily.
Exhibited by the ROYAL METEOROLOGICAL SOCIETY.

79. **Two Photographs of Lightning** taken at Tynemouth on August 9th, 1884, during a severe storm at 9 p.m. The focussing was done on the lightning flashes which followed each other very quickly. Six exposures were made, but four were spoiled by over-exposure. The two photographs exhibited were exposed about half a second. *Exhibited by* M. AUTY.

80. **Album containing 199 Photographic Portraits of the Fellows of the Royal Meteorological Society,** presented to G. J. Symons, Secretary. Feb. 19th, 1879. *Exhibited by* G. J. SYMONS, F.R.S., F.R.Met.Soc.

81. **Album containing the Photographs of the Stations of the Royal Meteorological Society** in the South of England, taken by Mr. W. Marriott during the inspection, 1884.
Exhibited by the ROYAL METEOROLOGICAL SOCIETY.

82. **Two Photographs of the Meteorological Station** at Lucknow House, Addiscombe, Croydon. *Exhibited by* E. MAWLEY, F.R.Met.Soc.

83. **Curves from Richard's Thermograph,** recording Dry and Wet on the same cylinder, as designed by Mr. G. M. Whipple.
Exhibited by E. T. DOWSON, F.R.Met.Soc.

84. **Diagram of Daily Rainfall** at Apsley House, Margate, for the year 1884.
Exhibited by J. STOKES, F.R.Met.Soc.

APRIL 15TH, 1885.

Ordinary Meeting.

ROBERT H. SCOTT, M.A., F.R.S., President, in the Chair.

The following Papers were read :—

"REPORT OF COMMITTEE ON DECREASE OF WATER SUPPLY." (p. 216.)

"REPORT OF COMMITTEE ON THE HELM WIND OF CROSS FELL, CUMBERLAND." (p. 226.)

"RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT ASUNCION, PARAGUAY." By RICHARD STRACHAN, F.R.MET.SOC. (p. 238.)

CORRESPONDENCE AND NOTES.

NOTE ON EARLY NOTICES OF THE RELATION BETWEEN ATMOSPHERIC PRESSURE AND WIND. By ROBERT H. SCOTT, M.A., F.R.S., President.

IN the March Number of the *Zeitschrift der Oesterreischen Gesellschaft für Meteorologie* there is a discussion as to the priority of the statement of Buys Ballot's law, and from this it appears that the earliest notices cited date from about the year 1853, the same year in which Prof. Adolph Erman's Paper, in which the same principle was stated, came out in *Poggendorff's Annalen* (Vol. LXXXVIII. p. 260). It appears that the claims to the honour of early recognition of this law of the late W. H. B. Webster, Surgeon R.N., have entirely escaped notice hitherto.

In his *Recurring Atmospheric Periods* (London, 1857), at p. 216, Mr. Webster institutes a comparison between the simultaneous barometrical readings at Greenwich and at Sandwick Manse, in the Orkneys, and he gives the following conclusion at which he arrived:—"A difference of one inch between the barometers of Greenwich and Orkney, or 500 miles apart, would produce a breeze of perhaps 9 or 10 lbs. pressure; but if a difference of two barometers at 250 miles apart amounted to one inch, the pressure or force of the wind would be 16 or 20 lbs. on the square foot. These are the fundamental laws as true and permanent on the atmosphere as in the celestial and planetary motions."

Mr. Webster had been anticipated by Prof. Buys Ballot and others in this statement, but it appears to me that in the following quotation, which dates twenty-three years earlier, he stated the general principles of the relation of wind to pressure over the surface of the globe in words which well deserve to be placed on record, and which stamp their author as a man of rare insight into the fundamental principles of meteorology. In the *Narrative of a Voyage to the Southern Atlantic Ocean in the years* 1828-30, *performed in H.M. Sloop 'Chanticleer,' Capt. the late Henry Foster, F.R.S., from the Private Journals of W. H. B. Webster* (2 Vols. London, 1834), we read, at Vol. I. p. 316, "Here it may be well to revert, while the facts are before us, to the remarkable difference between the height of the barometer at this place (the Cape of Good Hope) and at Cape Horn, the two Southern extremities of the great continents of Africa and America. The barometer at Cape Horn, Staten Island and New South Shetland scarcely ever reaches 30 ins., and the mean of the year is 29·3 ins. or 29·4 ins.; so that the mean state of the barometer at Cape Horn is absolutely under its lowest state at the Cape of Good Hope. And the average difference between the atmospheric pressure of Cape Horn and that of the Cape of Good Hope is nearly one inch of the barometer, or one-thirtieth part of the pressure of the whole atmosphere. But the same thing precisely occurs within a much smaller space than that between the two Capes; for at Valparaiso, on the coast of Chili, the barometer stands equally as high as at the Cape of Good Hope; so that within a space of a thousand miles there is a permanent difference of one inch in the pressure of the atmosphere. And if we suppose that at any time the barometer is high at one place and low at the other, we shall have at Cape Horn the barometer at 28·3 ins., while at Valparaiso or the Cape it will be at 30·6 ins., being an occasional (nay, frequent) difference of more than two inches. Now, if we consider these changes to take place principally in the lower strata of the atmosphere, which in fact must be the case, and that they range within the limits of five or six miles altitude, how great must be the difference of the weights and pressure of the reciprocal columns. It is not surprising, then, that there should be continual gales endeavouring to restore the equilibrium. From the foregoing statements it may be safely inferred that 'the mean height of the barometer at the level of the sea being the same in every part of the globe' is by no means correct; but, on the contrary, that every place has its own peculiar height of the barometer; and to this permanent variation, a circumstance not heretofore recognised, may be attributed the perpetual interchange and motions of the atmosphere.

"Every place has, no doubt, its own specific pressure and appropriate temperature, as well as that of magnetic and electric action. The laws which regulate the barometer are not yet thoroughly understood, nor does our present knowledge of hydrostatics solve the whole phenomena. Meteorology is a science yet in its

infancy, notwithstanding the vast mass of tables already supplied to it; and we want some master-mind to unravel the mysteries of the subject, and to propound the laws and principles of the science. It must be undertaken in a general way, and not with mere local observations. Are there not zones of atmospheric pressure as well as of temperature? The mean pressure within the tropics is 30 ins. with a very small fluctuation, a range of not more than 0·5 in. during the whole year; while that of the extra-tropical to the latitude of 40° perhaps have the highest mean barometer 30·2 ins. or 30·3 ins., and a greater range of fluctuations, amounting to an inch or an inch and a half. Again, in the cooler latitudes from 40° to 60° and upwards, there is an unequal and fluctuating range, the mean pressure being below 30 ins. and about 29·8 ins., with a wide range from 28·1 ins. to 30·8 ins., being two and a half inches.

"Of the Polar climes we have not sufficient evidence to state any thing with precision. It appears, then, that the extra-tropical or middle zone is the zone of high pressure, the inter-tropical of equal pressure, and that the cooler climes have the greatest change of pressure, combining both the highest and the lowest, but with the lowest mean pressure. Before predicting from the barometer, it is necessary to know its local mean and action. The foregoing conclusions are the result of observations at many places in each hemisphere."

Even if subsequent research may bring to light earlier statements of the truth of the dependence of air motion on pressure, I venture to think that the foregoing quotation from an English work which came out more than half a century ago deserves to reappear in the publications of the Royal Meteorological Society.

RECENT PUBLICATIONS.

American Meteorological Journal. A Monthly Review of Meteorology and Allied Branches of Study. May-July 1885. Vol. II. Nos. 1-3. 8vo.

The original articles are:—The "Cold Island" in Michigan, by W. M. Davis (4 pp.).—A Theory of the "Chinook," by L. A. Sherman (5 pp.). The "Chinook" winds are felt with great power in Oregon, Idaho, Montana, and even as far east as Dakota. They blow from the North-west, and are so warm that the snow disappears with wonderful rapidity before them.—The "Storm Glass" and its action, by H. H. Clayton (3 pp.).—The Inversion of the Wind's Diurnal Period at Elevated Stations, by A. L. Rotch (4 pp.).—The Huron Tornado of August 28th, 1884, by M. W. Harrington (5 pp.).—Protection against Lightning, by A. McAdie (6 pp.).—Thunderstorms aud Air Pressure, by H. A. Hazen (3 pp.).—Climate of Santa Fé, by M. W. Harrington (27 pp.).—Weather Changes of Long Periods, by H. H. Clayton (13 pp.). The author demonstrates that: 1. There are areas of barometric depression, and elevation, which occupy weeks and months in their movements across the continent from west to east. 2. There exist, independent of the movements of areas of barometric depression and elevation, numerous see-saw oscillations in the pressure which have been given the name of *surges*. 3. In front of, and to the south of, areas of barometric depression of slow movement and long duration, as in those of rapid movement and short duration, the temperature is above the normal; and below the normal north of them and in their rear, which is usually the front of barometric elevations. In front of, and to the south of, areas of barometric elevation of long period, as in those of short period, the temperature is below the normal, and above north of them and in their rear, which is usually the front of depressions. 4. In front of and within barometric depressions of long period, as in those of short, the rainfall is above the normal, and below in their rear. In front of, and within barometric elevations of long period as in those of short, the general tendency is toward fair and clear weather with deficient rainfall. 5. General weather predictions for long periods in advance are now practicable.

Annuaire de la Société Météorologique de France. 32me Année. August and September 1884. 4to. 1885.

Contains:—Fréquence de la pluie suivant les phases de la lune, par M. Cœurdevache (3 pp.).—Sur une pluie terreuse tombée aux iles Canaries du 21 au 22 février 1883, par L. Teisserenc de Bort (2 pp.).—Relation sur un cyclone rencontré par " le Salazie " à 500 milles dans le SE. ¼ E de l'île Maurice du 9 au 10 février 1884, par Capt. H. Macé (2 pp.).—Sur la distribution des pluies en Australie pendant la période 1871-80, par V. Raulin (22 pp.). The author gives the mean monthly seasonal and yearly rainfall for the period 1871-80 at a large number of places in Australasia, to which he also adds the latitude, longitude, and height above sea level of the stations.—Formation des principaux hydrométéores et nouvelle théorie de la grêle, par J. R. Plumandon (18 pp.).

British Rainfall, 1884. On the Distribution of Rain over the British Isles during the year 1884, as observed at more than 2,000 Stations in Great Britain and Ireland, with articles upon various branches of Rainfall work compiled by G. J. Symons, F.R.S. 8vo. 290 pp. and 9 plates. 1885.

This volume contains the records of rainfall from 2,495 stations. In 1860 Mr. Symons only received returns from 168 stations; and in order to show the great advance made during the past twenty-five years, he gives a reprint of the first of the series, viz. *English Rainfall* 1860, a pamphlet of four pages. The largest rainfall in 1884 was 184·75 ins., at the Stye, Cumberland, and the least 12·01 ins. at Chatteris, Cambridgeshire. In addition to the above records, this volume contains an exhaustive consideration of the best mode of representing monthly rainfall, articles on self-recording rain-gauges, on the drought of 1884, and other information.

Ciel et Terre. Revue populaire d'Astronomie, de Meteorologie, et de Physique du Globe. Deuxième série—1re année, Nos. 5-10, May-July 1885. 8vo.

Contains:—Les Tornados (3 pp.).—Le valeur des prévisions météorologiques au point de vue pratique, par E. Lagrange (3 pp.).—La foudre et ses effets sur les lignes télégraphiques et téléphoniques (5 pp.).—Fréquence relative des tempêtes dans l'hémisphère nord (4 pp.).—Quelques mots sur la météorologie des hautes régions de l'air (7 pp.).—Les saints de glace, par J. Vincent (7 pp. and plate).—Les conditions climatériques du bas Congo pendant la saison sèche, par Dr. J. Chavanne (8 pp. and plate).—Le culte des phénomènes atmosphériques chez les peuples primitifs (9 pp.).—Les rivières et les lacs de la Russie (3 pp.).—La scintillation des étoiles dans ses rapports avec les phénomènes météorologiques, par C. Montigny (10 pp.).—Production de filaments de glace à la surface du sol, par W. Prinz (2 pp. and plate).—L'établissement de stations météorologiques de premier ordre au Congo, par Dr. A. von Danckelman (4 pp.).—La température de la terre (3 pp.).

Hongkong. Annual Weather Report for 1884. By. Dr. W. Doberck, Government Astronomer. Foolscap folio. 1885.

This observatory was not thoroughly equipped till March, so that the means of many of the elements are not complete for the year. The mean barometric pressure for the year was 29·972 ins.; and the total rainfall 75·42 ins. No rain fell in the months of January and December.

Meteorologische Zeitschrift. Herausgegeben von der Deutschen Meteorologischen Gesellschaft. Redigirt von Dr. W. Köppen. Zweiter Jahrgang, Nos. 5-7, May-June, 1885. 4to.

Contains:—Ueber den jährlichen Gang der Luftfeuchtigkeit in Norddeutschland, von Dr. H. Meyer (10 pp.). In this paper on the yearly range of atmospheric moisture in Germany, the author discusses three elements,—vapour tension, relative humidity, and the dryness: being the amount in vapour pressure required to saturate the air from time to time. These are all calculated in monthly values for twenty-six stations.—Intensitätsmessungen des diffusen Tageslichtes,

von Dr. L. Weber (15 pp. and plate).—Experimentelle Darstellung von Luftbewegungen unter dem Einfluss von Temperaturunterschieden und Rotations-Impulsen, von Dr. Vettin (11 pp. and plate).—Temperaturänderung mit der Höhe in Berglandern und in der freien Atmosphäre, von A. Woeikoff (18 pp.). This paper on the distribution of temperature with height, as shown by mountain stations and balloon ascents, is a translation of a chapter in the author's work on Climatology, which has only appeared in Russian. He points out that British Meteorologists must not expect the phenomenon of inversion of temperature to occur at Ben Nevis so often as it does at southern mountain stations, inasmuch as Ben Nevis comparatively rarely lies within an anticyclone, and it is only with these that the temperature on the top is higher than below.—Der Frühling 1885, von Dr. E. Duderstadt und Dr. J. van Bebber (6 pp. and plate).

SOCIETÀ METEOROLOGICA ITALIANA. BOLLETTINO MENSUALE pubblicato per cura dell' Osservatorio Centrale del Real Collegio Carlo Alberto in Moncalieri. Serie II. Vol. IV. No. XI.—Vol. V. No. III. November 1884—March 1885. 4to.

Contains:—La Società Meteorologica Italiana all' Esposizione Generale Italiana (5 pp.).—Sopra la disastrosa Meteora del 7 ottobra in Catania, del Prof. O. Silvestri (5 pp. and plate). This whirlwind traversed about twenty kilometres of the country near Catania, producing great devastation along a zone about 650-700 metres in width.—Le Valanghe nelle Alpi nel mese di Gennaio (2 pp.). As very disastrous avalanches had fallen in January, circulars were drawn up and distributed in order to gain information, so that an accurate study of the phenomena might be undertaken by the Italian Meteorological Society.—Risposta ad alcune Obbiezioni ripetute contro le osservazioni microsismiche in occasione del terremoto d' Ischia del 1883, del P. D. T. Bertelli (24 pp.).

SYMONS'S MONTHLY METEOROLOGICAL MAGAZINE. May-July 1885. Vol. XX. Nos 232-234. 8vo.

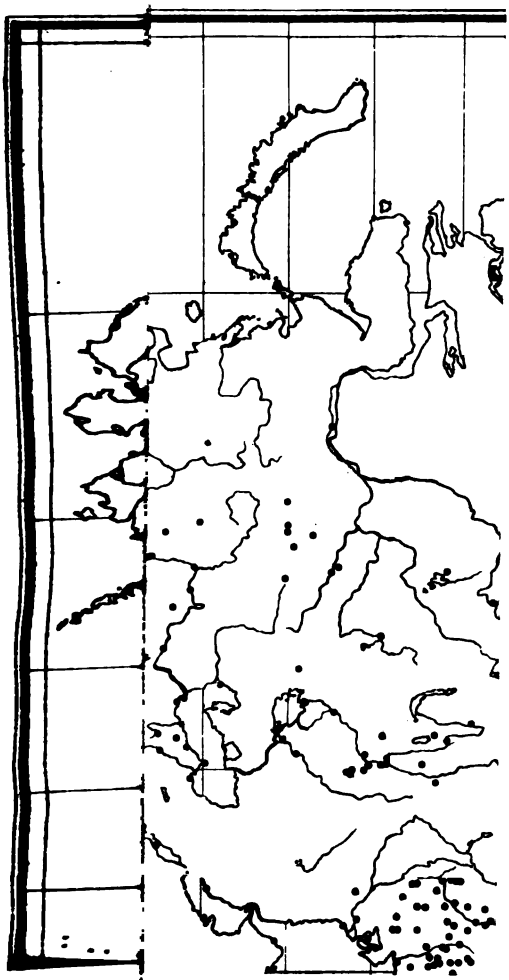
The principal articles are:—Rainfall in Madagascar (2 pp.).—Notes on the Weather of a Century ago, by C. Tomlinson, F.R.S. (2 pp.).—A Floating Mid-Atlantic Meteorological Observatory (2 pp.).—Atlantic Tides as Storm Warnings, by G. W. Brenan (1 p.).—On the Relative Humidity and the Dryness of the Air, by G. Dines and R. Strachan (4 pp.).—M. Hervé-Mangon's Iron Tower (2 pp. and plate).—The Frozen Ground at Yakoutsk (2 pp.).—Frost of 1739-40 (2 pp.).—Scintillation and Weather Forecasting (6 pp.).—Extraordinary Fall of Rain and Snow in Vienna, May 15, 1885 (2 pp.).

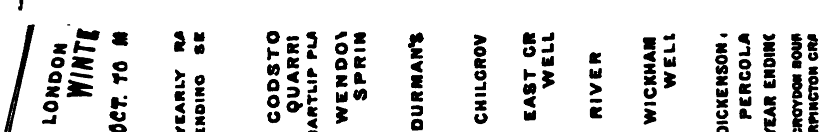
ZEITSCHRIFT DER ÖSTERREICHISCHEN GESELLSCHAFT FÜR METEOROLOGIE. REDIGIRT VON DR. J. HANN. Band XX. May-July 1885. 4to.

Contains:—Ueber die Bestimmung der wahren Luftemperatur, von H. Wild (15 pp.). This is a reply to Mr. Hazen's paper on the same subject which appeared in the *American Meteorological Journal*, Vol. I. p. 3421. Prof. Wild defends his own methods and the results he has obtained, and concludes with the remark that Mr. Hazen's assertion of the completeness of his mode of attacking the problem is premature.—Die tägliche Periode der Windrichtung auf dem Obirgipfel und dem Säntis, von Dr. J. M. Pertner (5 pp.). In the *Meteorologische Zeitschrift* (Berlin) for January 1884, Dr. Sprung had announced that the wind at plane stations or on table lands changes with watch-hands in the forenoon, and against watch-hands in the afternoon; and on peaks that the change is exactly the reverse. Dr. Pertner has analysed the observations on the Obir, and finds that the statement of Dr. Sprung is not confirmed.—Die Regenverhältnisse des malayischen Archipels, von A. Woeikoff (11 pp.).—Lancaster's Untersuchungen über die Gewitter in Belgien 1879, von Dr. H. Klein (5 pp.).—Die Bessel'sche Formel bei unvollständiger Amplitudenreihe, von Dr. K. Weihrauch (5 pp.).—Ueber den täglichen Gang der Bewölkung, von J. Liznar (10 pp.).—Die Regenverhältnisse des malayischen Archipels, von A. Woeikoff (23 pp.). This is a continuation of a previous article, and it deals with the rainfall on the east of Java, which is much drier than the western part of the island. In concluding Dr. Woeikoff remarks that the prodigious daily falls noticed at Batavia and elsewhere do not bear such a high proportion to the total annual falls as holds in certain much drier regions, as *e.g.* the shores of the Caspian Sea.

S OVER THE GLOB

EAST ONE YEAR, EXISTS.





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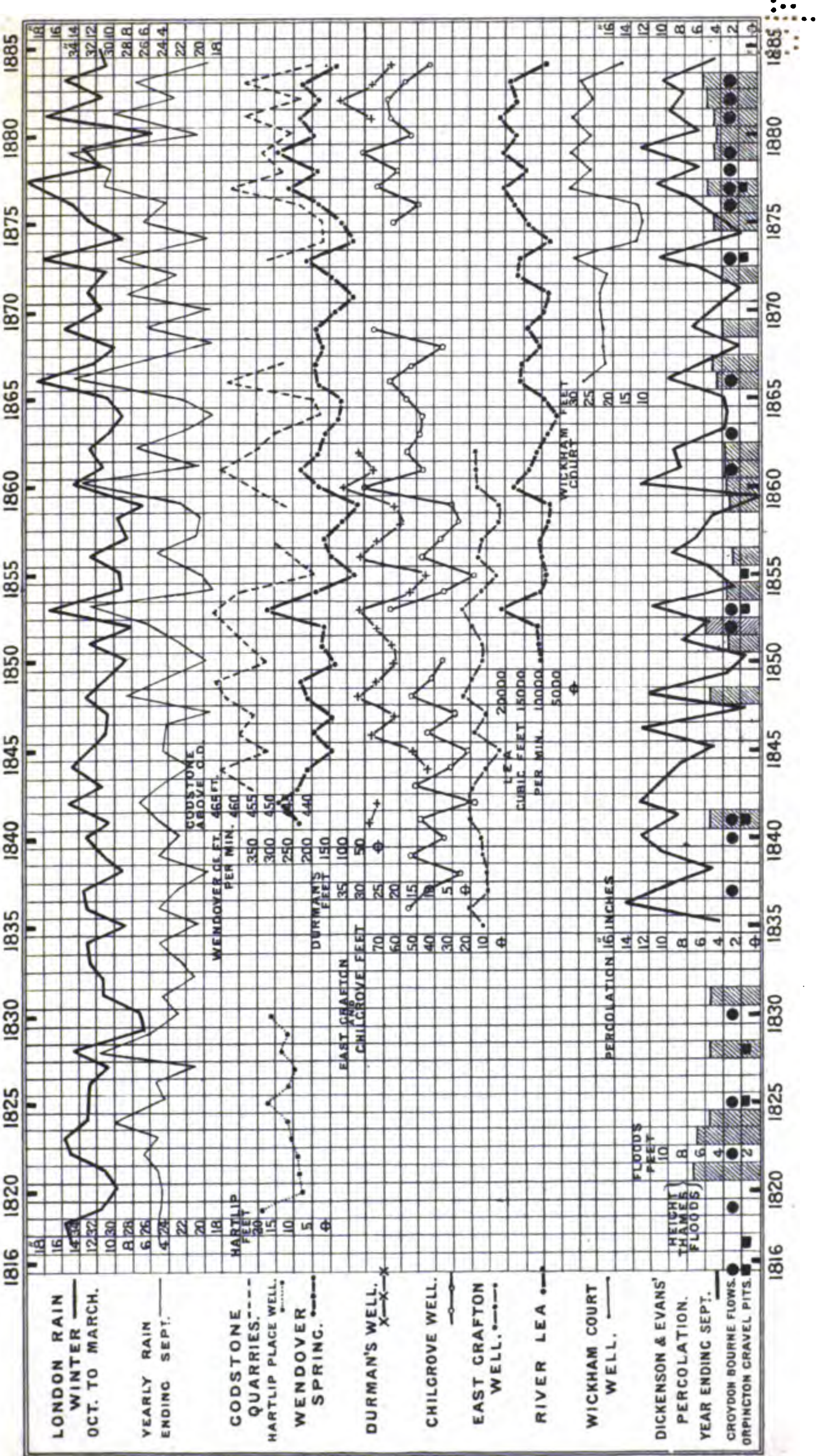
VOLUME OF SURFACE AND UNDERGROUND WATER.



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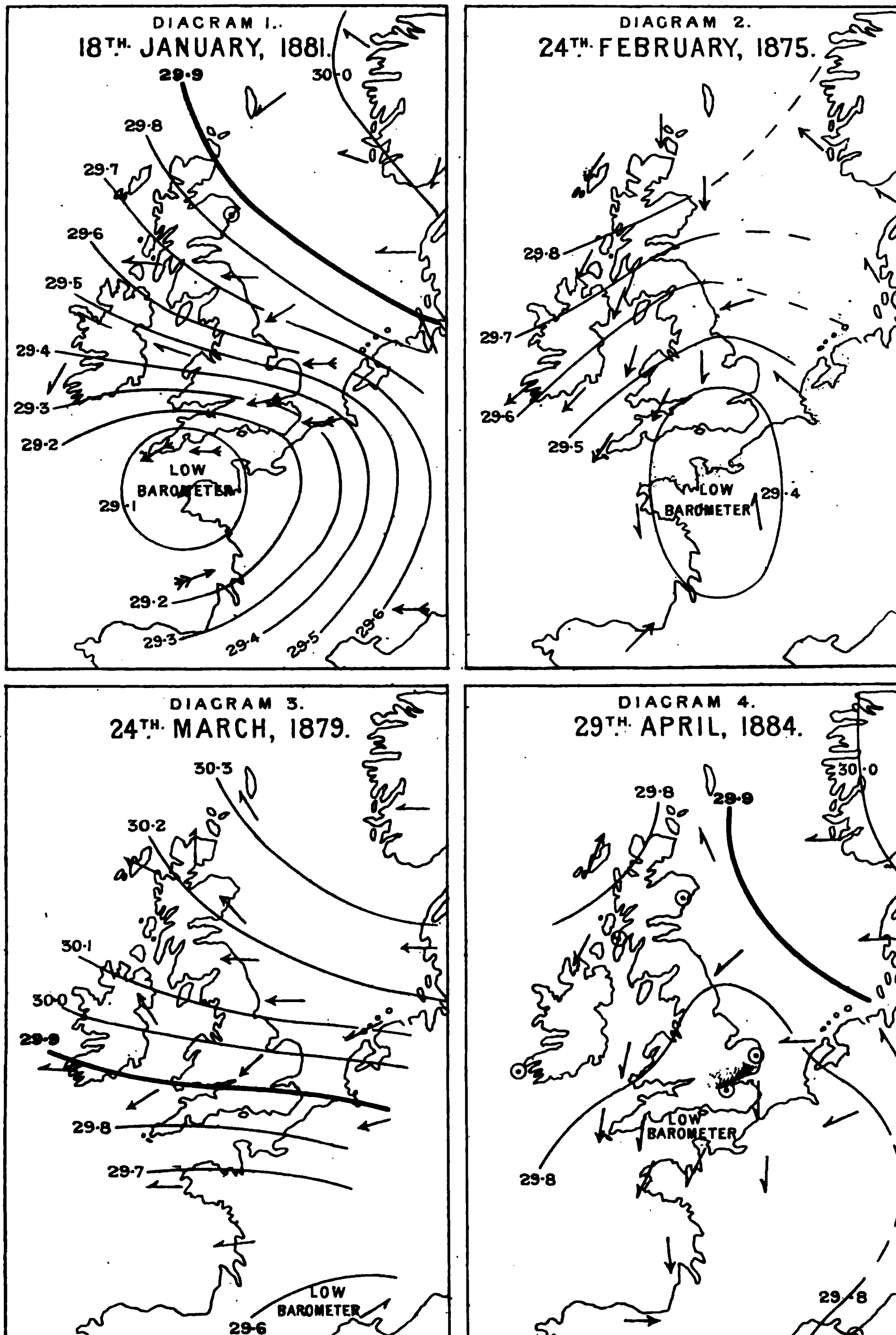
TYPICAL WEATHER WITH HELM WINDS.



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WIND.— ⊙ - *dead calm*, → - *forces 1 to 4*, → - *forces 5 to 7*, → - *forces 8 to 10*, → - *forces above 10.*

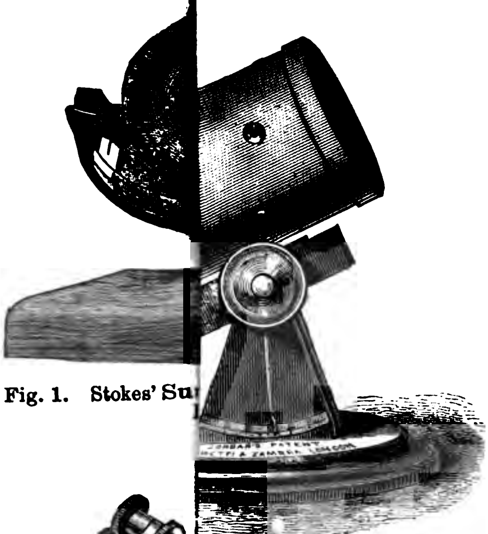


Fig. 1. Stokes' Su

rdan's Sunshine Recorder.

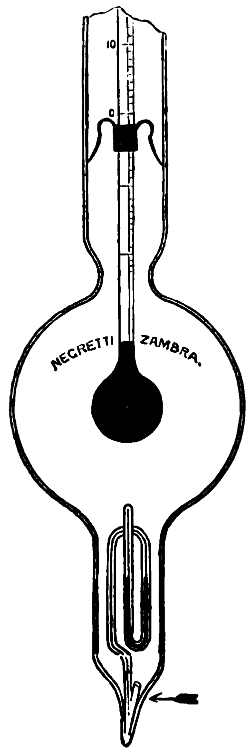


Fig. 8. Black bulb Max. *in vacuo*, with mercurial test gauge.

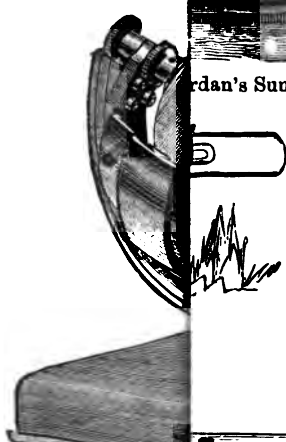
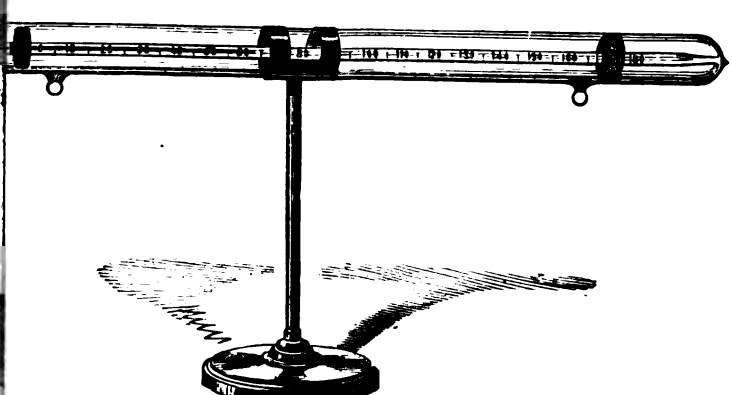


Fig. 2. U



ig. 9. Black bulb Maximum *in vacuo*, with platinum wire.

Fig. 3. Suns

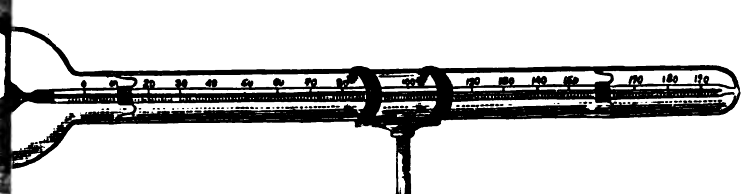


Fig. 10. Black bulb Maximum *in vacuo*.

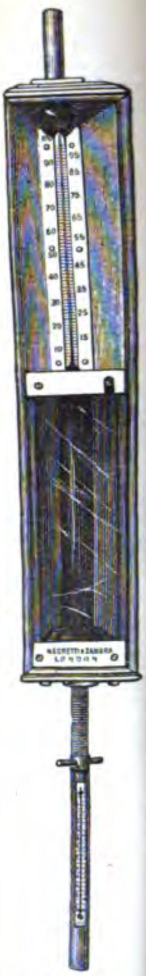


Fig. 11. Herschel's Actinometer.

Fig. 21. Minimum with parabolic metallic Reflector.

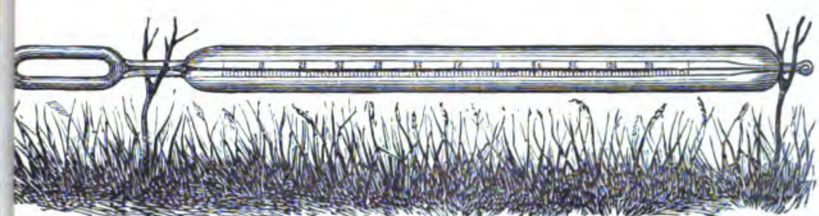


Fig. 22. Link-shaped bulb Minimum.

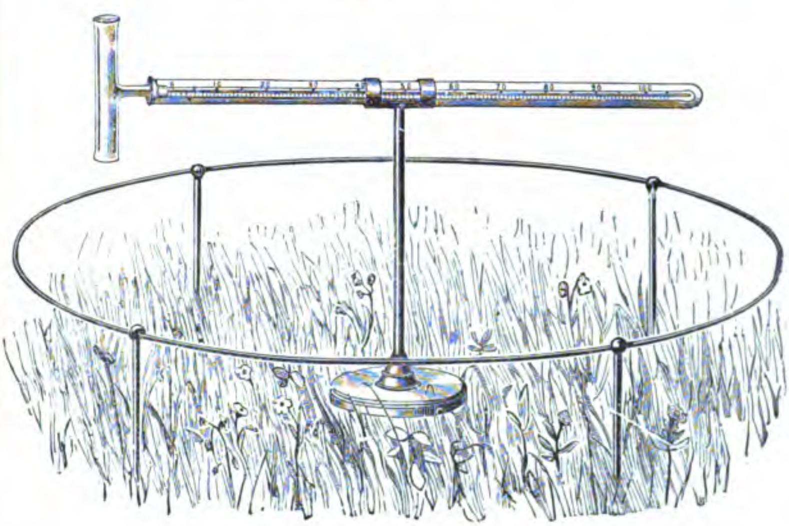
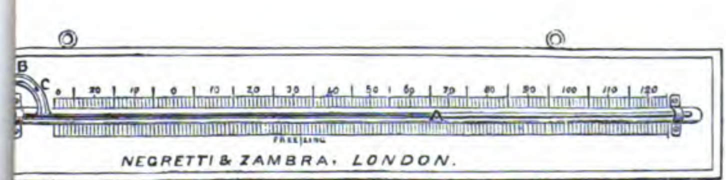


Fig. 23. Hollow Cylinder Minimum.



egretti and Zambra's Mercurial Minimum.

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CONTENTS.

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SESSION 1885-86.

DATES OF MEETINGS.

November	18	March	17
December	16	April	21
January*	20	May	19
February	17	June	16

* Annual General Meeting.

The Chair will be taken at 7 p.m.

By permission of the Council of the Institution of Civil Engineers, the above Meetings will be held at 25 Great George Street, Westminster, S.W.

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THE TEMPERATURE ZONES OF THE EARTH, CONSIDERED IN RELATION TO THE DURATION OF THE HOT, TEMPERATE AND COLD PERIODS, AND TO THE EFFECT OF TEMPERATURE UPON THE ORGANIC WORLD. By Dr. W. KÖPPEN, Hon.Mem.R.Met.Soc.[1] (Plate IX.)

[Read May 20th, 1885.]

BOTH Man and the whole organic world have a twofold dependence upon climate. On the one hand, temperature and water-supply have a direct influence upon the processes of life; on the other, they exert an indirect influence by supporting or destroying other kinds of organisms. The direct dependence upon climate is most evident in plants and cold-blooded animals; the indirect effect of climate is the more important in warm-blooded animals, inasmuch as their bodies, by virtue of a wonderful mechanism, enjoy an almost complete independence of the temperature of the surroundings. It is not so much the rigour of the weather that limits or prevents the settlement of mankind in the vast ice wastes of the Polar regions,—for we find, during a portion of the year, quite as great a degree of cold in parts which are comparatively thickly populated,—as the difficulty or impossibility of procuring suitable organic food, and especially the absence of food plants. Climatic diseases form a middle term between these two groups of causes, as they are becoming more and more traceable to the effect of minute organisms,

[1] Translated by J. S. Harding, F.R.Met.Soc., from the *Meteorologische Zeitschrift*, Berlin, for May 1884.

while formerly they were regarded as the direct effect of climate or of inorganic conditions.

The direct effects of temperature also, which are evinced in such a striking manner in the case of the higher plants, are of a different kind; for instance, the immediate fatal effect of a certain degree of heat must be distinguished from the influence which temperatures that fall within the limits necessary to life have on the rapidity and intensity of the processes of life. Whilst in our countries the obstacle to the cultivation of one shrub is that it is exposed to frost, in another it is that in the short or cool summer the wood has not ripened, that is to say, the necessary annual cycle of the processes of life has not completed itself. In many cases also the available heat, although sufficient for individual existence, is not so for the formation of ripe seed, and hence propagation of the species is not possible without continual colonisation or the assistance of man. We find here also manifold interconnection of the causes; whilst, for instance, the unripened wood freezes more easily, on the other hand the partially frozen plant can make less use of the warm period when that comes. We know, from Sach's investigation, that the budding, and possibly also the subsequent growth, of plants proceed most rapidly at a certain definite temperature, termed by him the *Optimum* temperature, and that they proceed more slowly in proportion as the temperature deviates above or below this amount until at a certain difference they become *nil;* then first apparent death, and, at a greater difference from the *Optimum* point, actual death, sets in.

Higher organisms can only exist when the temperature of their sap does not rise above a certain point, at the highest between 40° and 50° C, and when it does not fall below a certain amount in proportion to its degree of concentration, which is, however, not far from 0° C. In the first case, coagulation of the albumen occurs; in the latter case the sap freezes. This latter condition certainly only partially suspends life in many plants and also in some rather highly organised animals, and if a thaw sets in sufficiently gradually it is followed by resuscitation. An attempt has often been made to express by formulæ quantitatively the undeniable influence of temperature on the rapidity of development of plants. Complicated hypotheses, such as that the duration of a phase of development is proportional to the square (Quetelet) or to the square root (Babinet) of the height of the temperature above the freezing-point, have met with no satisfactory reception. The recognition that it is only in the case of temperatures above certain sprouting temperatures (minima), which are different for all plants and organisms, that the length of the period may be substituted for the height of the temperature, has rendered the idea of calculating from the freezing-point obsolete.

The assumption that the product of the time by the height of the temperature above such a base line gives a correct measure of the effect of temperature on the plant has, however, even now zealous defenders, although it cannot be denied that this also rests upon arbitrary suppositions. It is not surprising that in the majority of cases tolerably concordant "sums of temperature" can be obtained for the different years by the assumption of

different values for this base, especially where the base is not directly determined, because it is undeniable that vegetation is developed earlier in warm than in cold years, and it is only a question of the amount and character of this influence. The limits afforded by free nature within which the comparison is made are, however, very narrow.

Under such circumstances, it appears more advisable to disregard all preconceived assumptions, and to keep only in view the duration of the time during which the temperature stands above or between certain limiting values. In this manner Griesbach has succeeded in rendering more intelligible many important limits of vegetation by the duration of the time of vegetation of certain plants. He showed that their distribution ceases where the period during which the extreme conditions for the vegetation of the plant are favourable sinks below a certain limit.

On making a critical investigation into the areas of distribution of the growth of timber trees in Russia, I was especially interested by a peculiarly formed belt, in which the limits of many of the commonest trees and shrubs of Central Europe fall, and which stretches from the Gulf of Finland eastwards to the Ural, and then southwards and south-westwards to the lower parts of the valleys of the Volga and the Don. In this belt of about only 300km. in breadth, we find the limits of the Oak (*Quercus pedunculata*), Elm (*Ulmus effusa*), Maple (*Acer platanoides*), Hawthorn (*Crataegus Oxyacantha*), Hazel (*Corylus avellana*), Spindle tree (*Euonymus verrucosus*), and the Crab Apple (*Pyrus malus*); and these are at the same time the furthest north-easterly representatives of their genera,—while some other kinds of trees, such as *Alnus glutinosa*, *Prunus spinosa*, and *Rhamnus cathartica*, whose limits also fall within this belt, possess very near relations (*Alnus incana*, *Prunus padus*, *Rhamnus frangula*), which go further to the north.

In Western Russia the Lime and Ash also reach their limits together with the trees just mentioned; but in the east the Lime grows somewhat further to the north than this, even beyond the Ural, while the Ash remains behind towards the south-west, so that it only reaches the Volga somewhat below Nijni-Novgorod. The northern arm of this limiting belt lies where the normal duration of the period, with daily means above 10° C, lasts less than four months. The south-easterly arm is bounded by the continental steppes, which are unfavourable to all tree-growth, as there is insufficient rainfall for the high rate of evaporation. There is no doubt that in both cases historical (geological) conditions also, such as competition with other organisms, co-operate in determining the special position of these limits, as the same species may be cultivated by man somewhat to the north, and to the south-east, far beyond their natural limit of distribution. Isolated stations where these could thrive beyond this limit without human aid undoubtedly exist in considerable number in Northern Russia and especially in Western Asia, but their great distance from each other and their small extent, in the midst of a foreign vegetation, which is better fitted for these conditions, renders the immigration and the maintenance of the species in these parts very difficult.

The Polar boundary of tree-growth is a still more important limiting line of a similar nature, and coincides very closely with the isotherm of 10° C in the warmest month. Where the normal duration of the interval with daily means above 10° C amounts to less than a month, trees no longer occur, even in a stunted condition, and the last forest islands in the Tundra lie every where close to this border line; on the other hand, the cold of the winter has no noticeable influence on tree-growth, and in the whole spacious basin of the Lena, as well as in the greater part of that of the Jenissei, lofty forests still flourish on a soil which thaws only in its uppermost strata. Nor does the mean temperature of the year in any way determine the conditions of vegetation.

We see how powerfully both the last-mentioned thermal limits—the duration of the mean temperature above 10° C for one month and for four months—affect the conditions of human life, when we mention that the culture of wheat nearly corresponds with the latter—the limit of oak trees; while beyond the forest limit not only is any kind of agriculture impossible, but the only animals of chase are almost exclusively to be found in the sea. It is easily perceived that the shortening of the time of vegetation, where agriculture is possible, affects man in a more direct manner by concentrating all his field work into a few months, and forcing him to find other employment during the long winter. Thus the contrast between the latter and the dreamlike short summer of the North must influence the psychical dispositions of the inhabitants of these climes.

Starting from such points of view, I have endeavoured to represent upon the chart the temperature zones of the earth from the standpoint of the permanence of temperature above or between certain "base values," according to the actual conditions prevalent upon the surface of the globe, without reduction to an ideal uniform level. The construction of a chart according to the distribution of temperature reduced to sea-level would have been much simpler; but I consider that the laying down of the conditions of temperature of the lowermost air-strata in contact with the actual surface of the earth to be more instructive, especially for the application of the chart to vegetable, animal and agricultural geography. I shall refer further on to the method adopted, and shall only remark here that I have purposely avoided going into small details, in order not to mask essential features by intricate representation of doubtful details. In the case of mountains, I have therefore only given those extending over wide regions, and have disregarded the others; this was the only method practicable, owing to the small scale of the chart.

I have chosen as the base, temperatures of 10° and 20° C in the daily means, and as the characteristic interval of time, in accordance with the above-mentioned relations of the "tree limit" and of the "Oak climate," one and four months. The consideration of the daily changes of temperature would introduce a very interesting completion of the picture, but it will be proper for many reasons not to complicate the construction of the chart by these considerations. Other factors in the behaviour of temperature must

also exert a considerable influence upon the organic world, such as the variability of temperature both in Dove's sense and in that of Hann. For what we represent in charts, and consider to be available for plants according to the mean values for many years, is not available in individual years; and where the temperatures of the years vary much, the occasional unfavourable seasons (which occur sometimes in successive years) will make the actual conditions worse than they appear to be from the normal values. An example of such an effect might be given in the failure of the Oak and its accompanying trees in South-west Siberia, where, according to the mean values, although in a somewhat narrow belt, an "Oak climate" prevails and the rainfall is quite sufficient for luxurious tree-growth; nevertheless the Oak and its associates above-mentioned do not reach beyond the Ural. Only a few representatives (as the *Alnus glutinosa*) appear again in the first outlying slopes of the Altai mountains in island-like isolation. In the Barabá, on the contrary, Birch is almost the only timber, and grows most luxuriantly. As in Western Siberia, the mean variability, in Dove's sense (mean departure of a single year from the normal value), is greater than anywhere else in the world, we need not seek other causes for the exclusion of the above-named kinds of trees than the effect of this element, supported by another which also reaches extraordinary magnitude in Western Siberia, namely the variability, in Hann's sense, or the mean amount of the variations of temperature from day to day.

The number of combinations which the said limits of duration (one, four and twelve months) and of temperature (10° and 20° C) may form is certainly large. But practically only certain of them come into consideration, and therefore only seven different belts are distinguished in the accompanying chart, six of which are repeated in the northern and southern hemispheres, and these are often split up by mountains or by the contrast of conditions between land and sea.

1. The Tropical Belt embraces, according to our definition, the parts of the earth's surface in which the normal temperature always stands above 20° C. As these, with few exceptions, only rise above 30° C in continental parts on the northern edge of the belt in the warmest month, its characteristic is uniformly high temperature with small yearly variation, the division of the year depending only upon rainfall, &c. The belt stretches on an average from 20° N to 16° S, but its breadth is subject to considerable oscillations, because it is limited by cold currents on the west coasts of the continents, and partly by radiation in the interior of the continents at the time when the sun lies over the other hemisphere. It is still more limited by elevations of the land, while the warm currents on the east coasts and the uniform temperature of the oceans push the boundaries of the belt further polewards. The Tropical Zone, moreover, in East Africa and America is for the most part traversed by meridional mountain chains. Islands and coasts swept by the Trade Winds near the Equator show the character of this zone most clearly. The following examples will illustrate this—

	Samoa.	Cayenne.	Parà.	Zanzibar.	Colombo.	Batavia.
	°	°	°	°	°	°
Coldest month	24·1	26·1	26·0	25·2	26·5	25·3
Warmest month	26·7	27·7	27·7	28·1	28·6	26·4

2. In the Sub-tropical Belts moderate temperatures prevail for at the least one month, and at the most eight months, while in a hot season, four months at least in length, the high declination of the sun comes fully into account. Higher extremes of heat are reached in this belt than in the vicinity of the Equator, owing to the longer days and less amount of cloud. On the chart this belt is found separated in many parts into two or three sub-belts by red and blue tints. An almost tropical sub-belt, where the temperate and therefore relatively cool season, with the daily mean under 20° C, is only short and embraces less than four months, can be separated from the rest of the belt, in which the hot season lasts less than eight months. This remainder of the sub-tropical belt in the Southern Hemisphere and on the oceans generally (except on a small strip on the east coasts of the continents) exhibits no specially cool months with temperatures under 10° C. On the continents of the Northern Hemisphere, however, it includes extensive regions in which the temperature of the coldest month falls below this figure, and where we can therefore speak of a real winter. China Proper and the Southern States of the American Union belong, with the exception of the Southern Coast border, as much to the wintry portion of the Subtropical zone as do the southern section of the Aralo-Caspian basin, the central parts of Persia, Syria and Arabia, as well as parts of Greece and Southern Italy.

Material was wanting for drawing the red line over the seas and in the mountains of the lower latitudes, and these would have been worthless in those cases where the whole yearly oscillation is so small; for where the temperature of all months is at the most a degree or two different from 20°, it is somewhat indifferent whether this occurs for less or more than four months. Both belts are broad, and their difference important only where, as in the Sahara, the yearly oscillation of temperature is great.

3. The Temperate Belts of both hemispheres are split up into several sections, having this in common, that the moderate temperatures (10°-20° C) last at least four, and the hot (above 20° C) not more than four months. The two first sections of this belt, denoted by violet and dark blue, are complementary to each other, since the one, which never exceeds 20° C or falls below 10° C (denoted by "constantly temperate"), suits the oceans, the other, denoted by "hot summer," in which the temperature for one or more months falls below 10° C, suits the continents. The third section, on the contrary, denoted by "summer temperate, winter cold," forms an almost continuous belt around the whole Earth on the polar borders of both the others, and is separated from the constantly temperate belt by the isotherm of 10° C of the coldest month, and from the "hot summer" belt by the isotherm of 22° C of the warmest month. It seemed more instructive in this case to take this higher value, instead of 20° C, because it gives a better climatic limit, while the other would confine the belt, "temperate with hot

summer" to a small strip. A new intermediate district is certainly here and there produced thereby, where from one to three months exhibit over 20° C, but none 22° C. But this is not important enough to require representation upon the chart.

(*a*). The "temperate with hot summer" belt has a close relationship with the exterior "cold winter" portion of the sub-tropical belt, from which it is only essentially distinguished by the duration of the hot period. In this belt vegetation generally, except in Eastern North America and in East Asia, suffers regularly from drought in summer, so that irrigation is necessary for gardening, and partially also for agriculture. The high temperature only indirectly injures vegetation, in so far as evaporation increases. But as in these latitudes the great heat in the summer of continental regions is generally associated with little cloud and rainfall, heat and drought are closely connected in the greater portions of this belt, and the continental parts of it, being deserts or steppes, offer a strong contrast to the northern forest region. The combination of heat with humidity, which during a great portion of the year characterises the tropical belt, only occurs in the sub-tropical and in the "hot summer" belts in the monsoon districts of South and East Asia, as well as in the south-east border of North America and Brazil.

(*b*.) In the northern hemisphere, if we disregard the tropical mountains, the regions with constant prevalence of moderate temperatures form two separate areas in the Atlantic and the Pacific Ocean. In the southern hemisphere, however, the belt of this character is only interrupted by the South American continent, as it passes southwards of the southern points of Africa and Australia. But another striking irregularity is seen in the southernmost parts of the two last-named continents; isolated districts appear in which the temperature of the coldest month sinks lower, owing to the influence of the continent, than over the sea at its polar limit, and falls below 10° C. The "temperate hot summer" belt is only represented in the southern hemisphere by three small continental areas.

(*c*.) The third and exterior of the temperate belts, which we may call the "temperate with cool summer" belt, is characterised by a mean temperature lying between 10° and 20° C during at least four, and at most eleven months, and below 10° C for at least one, and at most for eight months. But months with a mean temperature above 22° C do not occur. The chart shows that this belt, which is at present the chief seat of human culture, terminates in the east with the Altai mountains, reappearing only in the Amur territory; and in fact this is nearly the case, and this condition is reflected in the vegetation in an increased degree (see above) in the disappearance of almost all leaf trees in the neighbourhood of the Urals, and their re-appearance in the Amur territory,—while between these regions the Siberian Pine Forests reach as far as the steppes of Central Asia in Western Siberia, only with occasional patches of Birchwoods. But the extreme steepness of the yearly temperature

curve, which is necessary for the disappearance of this belt, is not completely attained. A July of more than 22° C would be requisite for this, with a mean temperature of less than 10° C in the months of both May and September. At no known station does this difference reach the required magnitude of 12° C, but it does reach 10°·1 to 11°·1 C in Nertschinsk, Blagowestschensk, and Selenginsk; 9° to 10° C in Semipalatinsk, Barnaul, Irkutsk, and Urga. Accordingly the temperate belt, with summers of sufficient length, but without regular heat, is not entirely extinguished, on the northern limit of Central Asia, but at all events it is only represented by very narrow and irregularly formed bands (principally owing to the mountainous nature of this border district).

4. The cold belt which here joins on the polar side, in which the number of temperate months sinks under four but not under one, and the period of vegetation is very much abbreviated, forms a continuous ring round the globe in both hemispheres. The cause that the breadth of this ring in the southern hemisphere is much less than in the northern, is the slight yearly variation of the temperature in the former, for in the southern hemisphere the difference between the latitude, where the coolest month sinks below 10° C (about 40° S) and where it is followed by the warmest (about 49°), is for this reason incomparably smaller than in Asia, where on the 100th meridian E the first limit lies in 22° N, and the latter in 72° N. The distances are therefore as 1 : 5½. Over a great part of the northern belt the ground, which in summer at a certain depth (completely at a depth of 28m.) maintains approximately the mean yearly temperature, does not thaw at all, although not only fine forests but in some places even cornfields thrive well at the surface. The dotted blue line, which, however, cannot lay claim to any accuracy, exhibits this extension of the frozen ground. Owing to the paucity and inaccessibility of materials, I have used Wild's calculation for the drawing of the lines, according to which the limit of the frozen soil must coincide nearly with the yearly isotherm of — 2° C. I have not been able to take account in the chart of isolated patches of smaller extent in this district, which must exist with every high mountain system.

5. Neither did the scale of the chart allow of a representation of the analogous exceptions to the greatest defect of heat in the polar belts. Only the accidental extension of the large regions of this kind in Central Asia have been regarded. The Equatorial and lower borders of this region do not coincide every where with the limit of tree-growth, because the defective summer temperature is certainly the most important, but not the only, cause of the failure of trees in this region. The cause of the failure of trees in the vicinity of the sea in high latitudes is only partially owing to the depression of the summer temperature by the sea, but partially due to the greater force of the storms, which in much lower latitudes, as for instance in North-west Germany, interfere with the tree-growth near the sea by whipping off the twigs where there is no shelter. On exposed coasts and islands the limit of

failure of trees is reached, as, for instance, on the Aleutian Isles—in a region where to all appearances the temperature reaches and exceeds 10° C for more than one month. And the same thing obtains on free plateaux and mountain peaks, where also the violence of the winds reduces the tree-limit much below the height which it attains on protected hillsides and in valleys,—of which a fine example is given in the Jailá mountains of the Crimea. It is easy to perceive that in many cases it is not one single hurtful condition, but the co-operation of several, that prevents the thriving of an organism; as each individual attack diminishes the power of the organism to overcome others.

In order to obtain an idea of the distribution of the air temperature at the actual surface of the earth, there is no other way than the use of orographic maps and calculation of the heights to which a certain temperature corresponds, from the temperature of any one level, and from the vertical decrease of temperature as deduced for the district and season, or as it may be assumed by analogy. It would be utterly absurd to attempt to draw the lines for such a chart merely from the direct data of a few accidentally distributed meteorological stations. The chart, moreover, as the first of its kind, needed only to represent the main features correctly; so that great accuracy in the calculations was not requisite. The assumed decrease of temperature amounts to 1° C for from 150 to 200 metres. The much more gradual decrease in winter, which characterises the continental northern regions, does not come into consideration for our purpose, as that falls far outside the season of vegetation. For my original level I have taken either the level of the sea and the existing isothermal charts as a basis, or else that of a station or group of stations for which the data have been well determined. For the United States and Norway, the charts of Schott and Mohn respectively were taken, which represent the distribution of temperature at the actual surface of the earth; those of Schott certainly refer to the mean of the seasons, and in using them I had first to apply a correction to reduce them to the period I had selected, which was done by means of a graphical interpolation with the help of the numerical values from neighbouring stations. The most important limits of height deduced for our regions in the mountainous parts of the earth may be shown in round numbers in the following table (p. 264):—

If we compare our Chart with the representations of yearly and monthly isotherms, which are now so common, we shall find at some points important differences, irrespective of the fact that on the existing charts of the world the isotherms are not yet given for the actual surface of the earth, but always for the ideal level of the sea. In general the lines of our chart, if they had been reduced to the same level, would have coincided much more closely with the parallels of latitude than the yearly isotherms do. This corresponds to the analogous behaviour of most of the limits of distribution of plants, which has been long remarked, and is in a great measure ascribed to the influence of light, of which the distribution is regulated by latitude, and has not such irregularities as the distribution of temperature. Our chart will show, however, that a great part of the limits of distribution are directly determined by the temperature conditions of the vegetation season. In fact,

UPPER AND LOWER LIMITS OF THE BELTS, IN METRES.

District.	Tropical.	Sub-Tropical.	Temperate "Hot summer."	Constant Temperate.	Temperate "Cool summer."
Mexico	0—500	500—1700	1700—1800	2200—2700	2700—3600
Equatorial Andes	0—1000	1000—1500	—	1500—3400	3400—3600
Peru (W. declivity)	—	0—200	—	200—1200	1200—2000
Rio Janeiro	0—200	200—1100	—	1100—	—
Guyana	0—1000	1000—1300	—	1300—	—
Gaboon	0—700	700—1000	—	1000—2400	2400—2800
Abyssinia	0—700	700—1600	—	1600—2300	2300—3300
Ceylon	0—1050	1050—1600	—	1600—2800	2800—3300
The Sunda Isles	0—1100	1100—1300	—	1300—2800	2800—3000
Himalaya	—	0—1600	1600—1800	—	1800—3600
Caucasus	—	—	0—340	—	340—1350
Armenia	—	0—850	850—1600	—	1600—2600
Altai	—	—	—	—	0—1800
Alps (S. declivity)	—	—	0—500	—	500—1400
Algiers	—	0—800	800—1650	—	1650—
Natal	—	0—500	—	500—950	950—2200
Cape of Good Hope	—	—	—	0—450	450—
Chili in 33 S. Lat.	—	—	—	—	0—1700

the districts on the chart in a great measure agree with those on Griesebach's Geographical Charts of Plants (*Vegetation der Erde*); also in Petermann's *Mittheilungen* 1866 and Engler's *Geschichte der Pflanzenwelt* (also in Meyer's *Conversations-Lexicon*, Yearly Supplement V.).

This agreement could with advantage be carried further by paying greater regard to the mutual relations between the geography of the organisms and climatology. But the present climate is only one of the two most powerful factors in the distribution of organic beings. The second, which is at least as important, is the historical. Engler has successfully devoted himself to the grateful task of separating these two factors in his researches and also in his graphical representations; but a great deal remains to be done in this direction, in order to illustrate more clearly the geography of the organisms. A precise statement of the position of the question by resolving it into its separate factors will do more to advance the science than continually drawing up new divisions of the Earth according to kingdoms of Flora or Fauna. And as man urgently requires system, especially so long as he is not able to command the material, the strict carrying out of various specific divisions according to fixed specific points of view will do more to further the subject than somewhat premature attempts to devise better natural divisions, embracing all characters.

If, in conclusion, we cast a glance at the relations of the temperature belts represented in the chart to the races of mankind and to civilisation, the fact is strikingly prominent, what an urgent need the present leaders of civilisation, the Europeans and their descendants, have of a cool season to invigorate their forces and brace them up for fresh campaigns in the development of that restless struggle "after a happy golden goal" which is the fundamental

condition of civilisation. A hot, even a very hot, summer does not prevent breathless "going ahead" in America; but where, however, the heat, even if tempered, extends over the whole year, and where the stimulating winter no longer obtains, Northerners who have brought with them ideal objects of work or have great speculations on hand may be able occasionally to go on for years; but indolence and listlessness is certainly the characteristic of the human race in such regions, and eventually seizes, if slowly, the more surely, upon the European immigrants. Further, so far as Europeans are concerned, there is the well-known impossibility of doing hard bodily work, or of exposing themselves unprotected to the sun in this zone on the continent without danger to life—a bar to activity of which the causes are not yet sufficiently explained, and which at sea, on board ship or on oceanic islands, does not exist to nearly the same extent. Hence the formation of colonies with purely European population in these regions is impracticable, and the white man can only hold a footing there as master over subjects of another race and only in isolated pursuits. But, as the chart shows, latitude does not entirely decide the matter, because there are provinces in every latitude, high up in the mountains, which offer the conditions of temperature required for white men, and which also presumably might maintain a compact population of European race—provided means of communication, which are generally deficient, and sufficient protection of rights were assured.

Great increase of intercourse has transferred the centre of civilisation in the course of time from those countries which are richest in natural products, continually further and further towards those which are poor in such products, but which are favourably placed for intercourse, and inhabited by a population with a highly developed sense of enterprise. Thus the civilisation of the old world has wandered out of the sub-tropical belt, where it had its chief seat up to the sixth century B.C., into the zone of "temperate with hot summer," while the belt with moderate cool summers, with the exception perhaps of the highlands adjoining the old civilised countries of Mesopotamia, &c. still lies buried in the depths of barbarism. In the course of the middle ages the difference in culture of these two belts in Europe became more and more equalised. The complete transference of the central point of intercourse, and also to some extent of the power, of Italy and the Levant to the Iberian Peninsula and from the Baltic to the North Sea in the period of the great discoveries, took place from east to west within the same belt. The speedy decadence of the power of Spain and Portugal, and the rise of Holland and afterwards of England, rendered, however, the translation of the centre of gravity of human civilisation towards the cooler zone an accomplished fact, and this the continually high standard of civilisation of the northern half of Italy, and its fresh advances in the most recent times, has not been able to alter.

In America also the analogous transfer of civilisation from the warm to the cooler countries is striking enough in the period since the beginning of the European settlement. But the old indigenous civilisation of this continent belonged here for the most part also to the temperate climate, as it was

concentrated on the plateaux in Peru as well as in Mexico,—and it is only in Yucatan that ruins of splendid buildings, now overgrown by tropical primæval forests, are to be found. The advantage which temperate climates possess over hot ones in awakening the sense of enterprise and the struggle after greater things is shown, therefore, in America even more than in the Old World. The more generally this principle becomes prominent, however, the more must the very isolated exceptions to it attract our attention, where we find grand ruins and remains of a comparatively high civilisation in the tropical lowland. Such are found nearest the Equator in Burmah, Siam, and Java. Others must decide whether the circumstance that we find them in Hindostan and Yucatan in the neighbourhood of highlands with a temperate climate, and in a certain genetic connection of the inhabitants with the latter, is essential for explanation of this exception. But, generally speaking, we must distinguish between, on the one hand, the forced enterprises of individuals, or of a caste ruling by despotic power over the inert masses, as we find them prominently represented in the hot countries; and, on the other, the sense of enterprise of the people itself or of a great portion of it, such as we find it with the population of the Mediterranean, and later still more with the populations of the Hanse Towns, Dutchmen and Englishmen. The first find the most favourable ground where the richness of natural production facilitates the nourishment of great masses of men, while their indolence renders it an easy task to subjugate them; while the latter for the most part take root under exactly opposite conditions.

The diffusion and energy of the human race in the temperate zone has resulted in an attack upon the geographical distribution of the animal world, to which as a rule sufficient attention has not yet been paid. By the extirpation of the large mammalia in this zone this attack had even in very early times created a much wider gulf between the tropical and arctic animals than was given to them by nature. It has confined to the torrid zone those animals which belonged to it in common with the temperate zone, and those whose area of distribution embraced the temperate and the frigid zone have been similarly confined to the frigid zone. And in this way it happens that the discoveries in Quaternary caves give us a mixture of animals of different climates, such as the lion and the reindeer, the hyæna and the arctic fox, the hippopotamus and the glutton. This would be inexplicable if we did not, even at the present day, find a similar if perhaps not quite such an extensive connection in those parts of the temperate zone in which a thin population with a very low stage of civilisation still exists. I refer to the Amur, where a short time ago, certainly in a small district, the tiger preyed upon the reindeer.

On the other hand, there are animals which, following the diffusion of the human race, extend their region of distribution, especially towards the cold zone; and not only parasites and domestic animals, but also such game animals as the hare, are included in this case. The deduction of changes of climate from the distribution of the higher fauna is therefore only possible by examining the question from all sides,

DISCUSSION.

Mr. ARCHIBALD said that Dr. Köppen's maps of temperature zones were extremely interesting. One very striking feature was that the hot regions extended so far south of the equator, but this could be accounted for when it was remembered that the zones represented the duration and not the degree of heat. It was pretty evident that these zones took no account of range of temperature, since from the map it would appear to a casual observer that the southern part of India was considerably hotter than the northern, whereas it was well-known to Anglo-Indians that in summer the North-west was considerably hotter than the southern parts.

Mr. BALDWIN LATHAM said that for some time past he had observed the temperature of trees. A hole was bored in the trunk of a tree and a thermometer inserted, which was read two or three times a day, and during different seasons. The results of these observations showed that there was something else besides temperature which destroyed trees and influenced their growth; and the most important of the other causes at work was the amount of moisture. This was particularly noticeable in the case of the ash and the oak, the ash appearing in bud before the oak when the condition of the ground was dry, but the oak coming into bud first and the ash being very late when the season was wet and cold. The ash was before the oak this year, the ground being in a dry condition. Trees could survive great cold, but not when combined with wetness of soil. Of course the growth of trees depended to a great extent on the character of the soil, and in fact the best test of the fertility of soil was the perfection of the culture of certain kinds of timber trees.

Dr. MARCET corroborated Dr. Köppen's remarks as to the effect of heat and cold on the energy and working abilities of man. He had for several winters lived in the South of France, where the weather is always warm, and could testify to the difficulty that was experienced in carrying on his work there. He then described the physiological effects of heat and cold in regard to their effect on man in the exercise of his functions.

Mr. LAUGHTON, referring to Mr. Latham's remarks, said that in the case of the great prairies of North America the absence of trees was considered by the American surveyors to be due not directly to the dryness of the climate, but to the great fires induced by the dryness. He also drew attention to the remarkable development of ferns in comparatively cold climates, as, for example, the higher latitudes of the West coast of South America, where the weather was uniformly cold and wet, but with no great extremes, and where ferns flourished in abundance. With respect to the effects of heat on man, it is a matter of familiar remark at all tropical seaports that naval officers go about in the heat of the sun without injury, in a way that no one else—except coolies—would think of doing. Perhaps this may be due to the effect of sea air on the constitution, which Dr. Köppen seems to refer to.

Mr. ARCHIBALD remarked that the growth of ferns appeared to be chiefly a matter of moisture. At Darjiling, where the rainfall was 120 ins. in the year, the ferns were most luxuriant. The mean temperature of Darjiling was about the same as that of London.

The PRESIDENT (Mr. SCOTT) said that the charts exhibited the duration of heat and cold, and that the reason for the area of the hot regions extending so far south of the equator was that those parts of the world have less range of temperature than those lying to the north, and consequently the number of hot months was greater. He had been informed by the late Mr. E. Blyth, for many years Curator of the Botanic Gardens, Calcutta, that while at that place there were great difficulties in making European fruit trees, such as apples, grow: it was the fact that in some parts of Hindostan the extremely hot summer played the part of the polar winter, checked the flow of sap in the tree, and allowed it to harden its wood, so that under these circumstances the trees of the temperate zone fruited in the torrid.

On the Equivalent of Beaufort's Scale in absolute Velocity of Wind.[1]

By Dr. W. Köppen, Hon. Mem. R.Met.Soc.

[Read May 20th, 1885.]

I wish to lay a few remarks before the Society with reference to the paper by Mr. Charles Harding, which appeared in the *Quarterly Journal* for January last (p. 39). I am glad that Mr. Harding has brought under discussion the extraordinary confusion which still exists with regard to the comparison of the different methods of estimating or measuring wind-force. It is not difficult to find instances in the literature of the subject which differ as widely as, or even wider than, those quoted by Mr. Harding, as regards the value assigned to the same figure of the Beaufort scale. I shall quote three English authors as examples :—

Beaufort Scale.		4.	5.	6.	7.	8.
Sir W. Snow Harris—Statute miles per hour		10	15	18	19	23
Smeaton ... ... " " "		28	32	40	50	60
White (*Naval Architecture*, 1877, p. 478)	Origl.—Naut. miles per hr.	—	14	17½	23	28
	Red.—Stat. " "	—	16	20	26	31

But these figures, and the greater part of other existing data, are arbitrary assumptions based upon very weak empirical or hypothetical foundations, and cannot be accepted as authoritative utterances.

I have taken Sir W. Snow Harris's figures from Findlay's *North Atlantic Memoir* (p. 179, 14th Ed.). The experiments with Lind's Anemometer referred to there appear to be intended only for calculating the relation between the velocity and the pressure of the wind; I do not know on what basis the relation of both to Beaufort's scale rests.

As the lower numbers of Beaufort scale are based upon the speed of the ship, and the higher upon the amount of sail carried, it would not be impossible to calculate on the principles of Hydrodynamics the wind velocities corresponding to these different rates of speed or amounts of sail (and consequently to the degrees of wind-force), for a given form and stability of the ship, paying due regard to its rig, both in still water and carrying certain amounts of sail. But the problem is so complicated and the calculation at present so devoid of all the necessary data, that we are absolutely driven to the purely empirical method, namely the determination of the required relation by comparisons of estimations with simultaneous anemometer readings. There are not many investigations of this nature, although they are tolerably easy to carry out. We must certainly content ourselves in most cases with estimations made on shore, because anemometrical observations at sea are both rare and difficult. In order that such comparisons may yield definite results, the estimations must, of course,

[1] Translated by J. S. Harding, F.R.Met.Soc.

actually correspond to the figures of Beaufort's scale, and the anemometer readings must denote the actual wind velocity at the very place for which the force is estimated. We are frequently too exacting in the former respect; for an accurate determination of Beaufort's scale according to the definitions is hardly possible, owing to the great variety of ships and of circumstances, and it becomes really only a question of the meaning which observers at sea generally attach to it. With regard to this, I can confirm—from our experience at the Deutsche Seewarte—Capt. Toynbee's remarks as to the close agreement shown between the estimations of different observers both at sea and at coast stations. On the other hand, too much confidence is usually placed in the scales with which our anemometers are provided. These are nearly all graduated on the assumption that Robinson's cups move with one-third of the velocity of the wind, whereas it has now long been established that cups of the usual dimensions move quicker—with about two-fifths of the wind's velocity, and more. I only know of two direct and somewhat extensive comparisons of Beaufort's scale and of wind velocity measured with Robinson's cups—that by Mr. R. H. Scott in the year 1874,[1] and that by Dr. Sprung in the year 1879.[2] Mr. Harding only quotes the first of these, and from a later reprint; the second is not even mentioned by him, nor is a short article in the *Oesterreichischen Zeitschrift für Meteorologie*, 1879, p. 302, in which I have endeavoured to combine the two investigations. I think, however, that Dr. Sprung's investigation merits very special attention, both for the extent and the nature of the materials used and for the close agreement *inter se* of the results obtained. One disturbing element in this discussion is that the constants of the anemometer were not determined, a defect I have, however, endeavoured to remove (in a similar way that Prof. Mohn has lately done) by calculating them by analogy, from the size of the instruments, in accordance with the experiments made at St. Petersburg—a deduction which I was able to test and confirm entirely by means of one of Prof. Recknagel's compared anemometers which was for some time erected at Hamburg near that of the Deutsche Seewarte. I found in this way that instead of the constant of exactly 3, according to the old Robinson hypothesis, it amounted to only between 2·34 and 2·40,—in round numbers 2·4,—in the anemometers of the stations of the Seewarte, where the arrangements of the instruments are as nearly as possible similar; while, on the other hand, a correction for friction of about 1 metre is to be added to the indications. Dr. Sprung, in his analysis, has compared the estimated wind-force with the mean anemometric velocity from 3594 observations made twice daily at four stations of the Seewarte, in the years 1876-78.

The following are the anemometrical velocities for the four separate stations, with their means and the calculated true velocities of the wind in metres per second, corresponding to the different degrees of the Beaufort Scale:—

[1] *Quarterly Journal of the Meteorological Society*, Vol. II. p. 109.
[2] *Archiv. der Deutschen Seewarte*, Vol. II. No. 1.

Beaufort Scale	0	1	2	3	4	5	6	7	8
Neufahrwasser	0·62	1·98	3·47	5·23	7·06	8·46	9·64	12·80	—
Swinemünde	1·18	2·38	3·99	5·67	7·59	8·64	11·13	12·06	14·76
Keitum	1·25	2·29	4·08	5·69	6·97	9·31	10·66	12·14	14·08
Borkum	1·14	1·64	3·42	5·40	7·26	9·26	11·15	12·18	13·56
Anemometer—Mean	1·10	2·12	3·72	5·48	7·25	9·01	10·99	12·15	14·23
True Wind Velocity — Metres per second	1·9	2·7	4·0	5·4	6·8	8·2	9·8	10·7	12·4
True Wind Velocity — Miles per hour	4	6	9	12	15	18	22	24	28

The indications corresponding to the wind-force 0 of Beaufort Scale have no real importance. For the figures 1 to 7, an increase of wind velocity of 8 miles per hour corresponds to an increase of one degree in the wind-force. But according to the Meteorological Office values it should be 5 to 6. Above figure 7 of Beaufort's Scale, at all events, the value of each degree is very much greater.

As a second check upon the above figures I have compared the monthly means of the estimated wind-force with those of the anemometrical indications (of two adjacent hours) for Hamburg. For this purpose I used the publications of the years 1878-80; but for the maximum wind-forces only, which were insufficiently represented (5 months only), I have also included the years 1881-2. The observations at this station were taken by different observers, the majority of whom were formerly sailors, as were also the observers at the other stations of the Seewarte. The following table contains the figures according to the form:—

NO. OF OBSERVATIONS. { MEAN BEAUFORT FORCE.
MEAN ANEMOMETER INDICATIONS.

Beaufort scale	1·8—2·5	2·6—3·0	3·1—3·5	3·6—4·0	4·1—4·5
8 a.m.	6 { 2·3 4·2	17 { 2·8 5·2	10 { 3·3 6·0	3 { 3·7 6·6	—
2 p.m.	—	5 { 2·8 4·7	16 { 3·4 6·2	10 { 3·7 6·4	14 { 4·2 7·7
8 p.m.	11 { 2·3 4·3	19 { 2·8 5·4	4 { 3·3 5·9	2 { 3·7 7·4	—
General mean	17 { 2·29 4·28	41 { 2·80 5·24	30 { 3·32 6·10	15 { 3·68 6·56	14 { 4·23 7·71
True velocity in metres per second	4·4	5·2	5·9	6·2	7·2

The last line contains the anemometrical indications converted by the formula

$$W = 1{\cdot}0 + 0{\cdot}8d^{*}$$

into true wind velocities, in the same way as in Dr. Sprung's investigations.

By interpolation we obtain from these figures the values for the whole degrees.

Beaufort scale	2	3	4
Mean Anemometer indications	3·73	5·57	7·23
Mean wind velocity, metres per second	4·0	5·5	6·8

* Where W is the true velocity of the wind.
1·0 the friction co-efficient in metres per second.
0·8 the factor to reduce Robinson's factor 3 to 2·4.
d three times the distance travelled by the cups.

These results are nearly identical with those of Dr. Sprung, although the observations were taken at another station, with other observers, and in different years,—but with an anemometer of the same construction. They differ considerably from the relation found by Mr. Scott (*Quarterly Journal*, Vol. II. p. 109) between the Beaufort Scale and wind velocity, which is adopted by the Meteorological Office, and printed in most text books. But it must not be forgotten that the figures used by Mr. Scott as velocities of the wind were obtained entirely on Robinson's old hypothesis that the wind velocity amounts to three times the velocity of the cups. There is now no longer any doubt that this factor is too high for the great majority of the usual patterns of the instrument, and Prof. Stokes's discussion of the experiments by Messrs. Jeffery and Whipple has shown that for the Kew pattern the factor is 2·5, and probably somewhat lower, exactly as I had deduced it for the very similar anemometers of the Seewarte. I do not know whether the anemometers at Yarmouth, Holyhead and Falmouth, which were used in Mr. Scott's discussion, were of the same pattern. It is certain, however, that the values should not be taken as wind velocities without correction. In the article in the *Oesterreichischen Zeitschrift* above mentioned, I have adopted the factor 2·4, and the friction constant of 0·8 metre per second, for these anemometers. By employing the results of all three stations and of all wind directions I have obtained values very similar to those given by the German stations; but I do not attach any weight to them, owing to the extraordinary divergence of the results of the individual stations and wind-directions in Mr. Scott's work, and my ignorance of the special conditions. The figures for Westerly winds at Yarmouth are far below those of the German stations, and it is evident that a comparison can only have general importance when the relations of the observers and the anemometers to each other are nearly similar in all winds, as they usually are or should be,—both being as free as possible from the influence of houses, and similarly affected by the general lie of the land.

In anticipation of the possible question whether German seamen do not generally estimate the wind-force too high relatively to Beaufort's definition, I would reply that in the same investigation Dr. Sprung makes a double calculation of the daily period of wind-force in the Trades, according to estimated forces and to distances sailed. From this it is seen according to seven very good logs that with a mean speed of six knots, and the wind dead aft, the mean estimated wind-force amounted to four degrees. Ships sail "full and by," as Beaufort requires, at least as fast with this wind-force as with the wind dead aft, according to the opinion of all seamen. As, then, force four of Beaufort's scale indicates five to six knots "full and by," the estimation of this Scale is somewhat too low in this case. This is easily explained by the fact that the wind-force is usually underestimated when sailing with it dead aft, since the relative velocity of the wind in this position is smallest, consequently the ship can carry all sail longer, and its force is generally less perceptible.

Assuming the values of Beaufort's scale as determined at the stations of

the Seewarte to be correct, no such difference will be found between the scales investigated and employed upon the Continent as exists between these and the Meteorological Office scale. The scale of ten parts employed in Russia in 1872 and 1873, and then fixed by graduation of Wild's "Pendulum" Anemometer, has been converted in the later Supplements to the Instructions for the Russian Stations (*Repertorium für Meteorologie*, Vol. IV.) into metres per second.[1] So far as I know, and as can be seen from p. 110 of the German Report of the Meteorological Congress at Vienna, these results are based on Dohrandt's testing of the wind-force plate by the rotary apparatus. As a check upon this I add the figures obtained by Mielberg about the same time, by comparing the indications of the wind-force plate, at the times of observation, with the indications of the verified anemometer placed upon the tower, and these agree very closely with the former.

Degrees of force of the 10 part Scale		1	2	3	4	5	6	7	8
Metres per Second.	Wild's plate...	2	3½	4½	6	7½	9	11	14
	By Mielberg	2·3	3·6	5·0	6·4	7·8	9·3	10·7	12·1

The new wind-force plate graduated directly in metres per second according to Dohrandt's experiments is, as is known, recommended by the Vienna Congress, and has since been much employed. In Norway, its indications are noted at twelve stations, together with the estimated wind-force, and have been discussed for the two months January and July 1876 (*See Year-book of the Norwegian Institute*, 1874, p. 3).

The results of probably the best station are given below, together with the mean of all the stations.

Estimated wind-force of the 6-part scale		1	2	3	4	5
Metres per second	Mean of 12 stations ...	3·3	5·9	10·0	13·9	17·5[2]
	Christiania	3·3	5·5	10·2	14·0	—

In order to obtain a clearer view we will compare together the three scales according to these wind velocities, and calculate to which degrees of the other scales the whole degrees of the 12-part German scale correspond.

The degrees of the 12-part scale (German Coast)	1	2	3	4	5	6	7	8
Correspond to:—								
In the 10-part scale (Russia)	1·5	2·5	3·6	4·5	5·5	6·4	6·9	7·5
,, 6 ,, (Norway)	0·8	1·3	1·8	2·2	2·6	3·0	3·2	3·6
,, 12 ,, (Met. Office)	0·5	1·2	1·8	2·4	3·1	3·8	4·2	5·0

While the estimations from Germany, Russia and Norway agree with each

[1] I do not know in what way Dr. Wild originally adapted his pressure plate (in Berne) to the scale of 10 parts.

[2] This force was only given by 10 stations—mean 16·9; but if we interpolate the two missing stations according to the range of the figures we obtain 17·5.

other tolerably well, that upon which Lieut. Brault bases his "Isanemonal lines," in his great charts published in the *Annales du Bureau Central Météorologique de France*, 1881, is plainly as much too low in the lower degrees as the scale of the Meteorological Office is too high. In the logs of the French ships used by Brault only 5 degrees of force are distinguished, the corresponding mean velocity of which being by Chazallon's method equal to 2, 4, 7, 12 and 18 metres per second respectively.

It is urgently to be wished that the question of the relation of the estimated scales to actual wind velocity should be cleared up by careful investigation, and by making use of the recent progress in anemometry, an end be put to the prevailing confusion. England is, for special reasons, well suited for such an investigation,—and I conclude with the hope that from experiments made there, we shall soon get the matter set right.

DISCUSSION.

Mr. LAUGHTON said that Dr. Köppen's Paper again called the attention of the Society to the chaotic state of our ideas of wind measurement. We have the Beaufort scale, velocity and pressure; and no one can say what any one of them means, or how it can be reduced to any other. He thought it simply discreditable that such a state of things should be permitted to continue, and he earnestly hoped that the Society would shortly see its way to take steps towards an attempt to introduce something like order and system.

PROF. ARCHIBALD thought that the words "Force" and "Velocity" in relation to wind were often spoken of as being one and the same thing, whereas force was totally different from velocity. It would be better to use one word only, and to omit "force" altogether. He did not see why the figures used in the Beaufort scale might not be made larger, or converted into miles per hour, for it would be as easy to estimate if the scale were larger as it is with the small and arbitrary scale now in use. Very little was known as to the relation between pressure and velocity, and the best attempt he had ever seen at establishing a relation between them was a theoretical one worked out by Ferrel. He thought it would soon become necessary to reduce all anemometer observations to one level, as it was now well known that the velocity of the wind increased with elevation, a fact to which he could give additional testimony from his experiments with kites.

Capt. TOYNBEE said that although the records of wind pressure and velocity by anemometers had been shown by Dr. Köppen to be in almost hopeless confusion, it must not be supposed that meteorologists are not obtaining very valuable records of the direction and force of the wind, which may be resolved into miles per hour and pressure on the square foot, when their inventive brethren have produced anemometers which agree amongst themselves, and which can be similarly placed. At present there does not exist any anemometer for showing the direction and force of wind which is to be compared to an intelligent use of Beaufort's scale by a trained observer. It seemed to him that the most promising improvement in our wind observations would be found in giving personal instruction to observers, by showing them how to make use of the objects which surround their stations. As an illustration of his meaning he pointed to his daily observations of the direction and force of wind taken from his office window. There he used the smoke from various chimneys as well as their cowls, and the direction and speed of the lowest clouds. With one direction of the wind the smoke from a certain chimney is very valuable, with another it is almost useless; the difference depending on the surrounding buildings. In no case would a vane and anemometer on the top of the office give a correct record of the wind's direction and force. He considered that his argument is illustrated by the fact that with a west wind (off the land) at Yarmouth, the anemometer recorded only half the speed that it did with an east wind (from the sea) for the same figure of Beaufort's scale recorded at the

lightship. This difference would not have occurred, if instead of an anemometer an intelligent observer had in both cases recorded the wind by Beaufort's scale.

Mr. GASTER explained at some length the manner in which the Table issued by the Meteorological Office had been prepared, and how the values furnished by observations made at one station had been checked by those made at others. He also added that it was beyond his power to understand how any one who had watched the drifting of smoke from chimneys in open places could possibly persuade himself that when a wind of force 8 was blowing the velocity of the air was not more than fifteen or twenty miles an hour.

Mr. C. HARDING said that the confusion between Beaufort's Notation and the equivalent wind velocity and pressure was very great. He showed the agreement which existed between the scale now used by the U. S. Hydrographic Office and that of Sir Snow Harris (quoted by Dr. Köppen). He also called attention to the wide difference between the scales of Sir Snow Harris and Sir Henry James; although Findlay's *Atlantic Memoir* refers to these scales as not differing very materially, an examination shows that the velocities in Sir Henry James' Table are 2·5 times as great as those given by Sir Snow Harris for the same grade of Beaufort Notation. He pointed out that after the alteration of the factor for the anemometer from 3 to 2·4, the velocities published by the Meteorological Office were still very different from those given by Dr. Sprung. He did not, however, attach any very great importance to Dr. Sprung's figures, because according to Dr. Köppen's statement the factor for the anemometer was not very satisfactorily determined. He did not like to admit that a sailor on shore was the very best observer of Beaufort's Notation, for in this case the sailor was without his ship, which when at sea constituted the whole argument in his choice of the different grades of the scale. He suggested the desirability of determining the proper equivalents of Beaufort's Notation, and graduating small anemometers to record in units of Beaufort Notation. He was very glad that Dr. Köppen had taken up the question.

Mr. CURTIS said that as there was very little doubt about the correct factor for the Kew pattern Anemometer, it was a pity that the factor 3, which was well known to be incorrect, should still continue in general use. With regard to Dr. Köppen's comparison, he had no doubt the equivalent velocities he had given were too low; but might not the difference between his scale and Mr. Scott's (the latter of course corrected for the wrong factor used) be, at all events partly, accounted for by the difference in position of the instruments and observers in Germany and England? An observer soon got into the habit of estimating wind-force according to the general character of the wind at his station, and force 10 at an inland, or less exposed coast, station was very different from that force at Holyhead or Scilly. Mr. Scott's comparison was based chiefly on observations made at very exposed places, and consequently a high velocity equivalent would be obtained for a given estimated force. On the other hand, in the Southern Baltic the exposure is probably very different, and therefore much lower velocities would be obtained, but without a corresponding difference in the estimated forces reported. At our Western Coast station a velocity of about 60 miles per hour (factor 2·5) is really very common with a force of 10, but probably at the Baltic stations such a velocity would be very rarely recorded.

THE PRESIDENT (Mr. Scott) said that all the figures referred to by Mr. Gaster would be found in the *Quarterly Journal*, Vol. II. p. 117. The Beaufort scale was founded on the amount of sail that a ship could carry under certain conditions of wind-force, and was formulated with the idea of making the estimation of wind-force easier and more accurate. The most complete corroboration of the Meteorological Office scale of equivalents, in miles per hour, for the Beaufort scale was to be found in Schott's discussion of McClintock's *Fox* observations in the Arctic Regions,[1] the figures agreeing remarkably well, especially in the higher parts of the scale. It would be, of course, a very easy matter to bring down the scale to the new factor values. Small hand anemometers were being introduced among observers of the Meteorological Office, in order to make comparisons between the instrumental records and the estimations of observers; but it was found that in some cases there was a danger of not obtaining true

[1] *Smithsonian Contribution*, Vol. 13 (No. 146).

estimations when observers had these instruments, as they read the instrument before entering their estimations. He believed the true key to the solution of the question of the disagreement of anemometrical registrations and reductions was to be found in the differences of exposure and elevation of the instruments.

Meteorological Observations made on a Voyage up the Nile in February and March 1885. By William Marcet, M.D., F.R.S., F.R.Met.Soc.

[Read June 17th, 1885.]

The following observations were made on a voyage up the Nile from Cairo to Assouan. From Cairo to Luxor I travelled with my party on board a dahabeeyeh, and from thence we continued to Assouan by steamer. The screen for my thermometers was made of a wooden box, the open side of which was closed to radiation, though not to free access of air, by a trellis of reeds tied together. I made a hole on the upper and lateral sides of the box to improve the circulation of air within it. This screen was secured at the northern end of a bench on the upper deck of the dahabeeyeh, its trellised side turned to the north, and it was protected at the back with pillows in such a way that no direct solar heat could strike on it. Care was taken to shelter the screen from the sun late in the afternoon by means of canvas. I had an opportunity of testing this plan by reading the instruments in the cabin with all windows open just after recording their indications in the screen, when the readings were found to agree. I should call a boat's deck cabin, through which a free circulation of air is maintained, not a bad check on the influence of radiation. On my return home I obtained the Kew corrections for my four thermometers, and every "reading" reported in this paper has been duly corrected.

My observations relate mainly to nocturnal radiation and the temperature of the water of the Nile; but I kept daily records of temperature and humidity, on which I shall beg to offer a few remarks.

Having left Cairo for Assouan (450 miles nearly South) on February 4th, the maxima showed no positive tendency to rise until the 20th, by which time I had travelled 171 miles to Beni-Hassan nearly South. The mean daily maximum from February 5th to 20th (inclusive) was 68°·9, and the readings ranged between 67°·8 at Cairo and 73°·8 on the 19th, fluctuating irregularly between these two extremes. A steady rise commenced on February 21st, at Rodah 182 miles from Cairo; on that morning I happened to be out on deck before sunrise and felt the air extremely cold; the maximum that day rose to 78°·8, and on walking up to the caves of Beni Hassan the heat, being the first we had experienced, felt oppressive. Between February 21st and March 15th the maxima varied from 73°·8 to 96°·7. On March 15th we were on our way back, and at a distance of 317 miles south of Cairo by river. That day, although marked by our highest maximum, was an exception to our constantly clear sky, the sun was not powerful and at times

disappeared behind the clouds. In the cabin at 2 p.m. the temperature was 85°·8, we all perspired very much, even the Arabs rowing, whom I had never seen to perspire before. At 3 p.m. under the screen, with clouds before the sun, the dry bulb thermometer reading was 90°·4, the wet bulb 73°·3, showing a difference between them of 17°·1. At 3.45 p.m. in the cabin with all the windows open the thermometers registered, dry bulb 94°·0, wet bulb 77°·8, giving a difference of 16°·2. At 4.35 p.m. the temperature on deck in the shade of a thick sail-cloth awning was 93°·5, at 5 p.m. there was a sudden fall of temperature to 83°·6 under the awning. This is an instance of considerable terrestrial radiation checked by clouds; there is an abundance of moisture in the region of clouds but the hot sandy desert dries up the air near it. I should not, in so dry an atmosphere, have expected to see people perspire as the Arabs did, the secreted moisture usually evaporating under a clear sky and leaving the skin dry.

On sixteen consecutive days (one observation omitted) the maximum reading was 80° or above. These sixteen days ranged from March 1st to 16th, and between lats. 26°·37′ N and 24° N. The time for the maximum temperature was as a rule very near 4 p.m., instead of 2 p.m. its usual time in London, as stated in Mr. Scott's *Elementary Meteorology*. At 4.30 p.m. a fall of temperature was usually appreciable. The mornings were cool till about 10 o'clock, but at 11 a.m. we became unpleasantly conscious of the heat. The distribution of temperature throughout the day was fairly constant, which might have been expected under the perfectly clear sky of Upper Egypt; it varied, however, somewhat according to the nature of the country. Thus while skirting the high limestone cliffs of the Arabian hills on the East, the heat these absorbed was given off in the afternoon, and caused the maximum temperature to remain permanent for some hours. This phenomenon was particularly well illustrated on March 15th, as we were skirting the chain of hills known as the Gebel Seyah, rising in slopes to about 1,000 feet. The colour of the rock was a yellowish red or burnt sienna, in no way recalling the white Dover cliffs. The following were the temperatures observed:—

	°		°		°
11.0 a.m.	81·4	4.10 p.m.	89·5	5.20 p.m.	87·7
2·38 p.m.	85·0	4.20	89·5	5.30	85·9
3.5	88·6	4.30	89·5	5·40	84·1
3.25	89·5	4.40	89·5	5·50	83·2
3.38	88·6	4.50	90·4	5·58	sun just set.
3.50	88·6	5.0	90·2	6·0	82·2
4.0	88·6	5.10	89·5		

The minima were as a rule surprisingly low, considering the temperature when the sun was on the horizon. The mornings before sunrise always felt cool, the lowest reading being 38°·1 on February 21st in lat. 27°·55′ N, the maximum that same day rising to 78°·8. As the season progressed and as we reached further south the minima read higher, but they began rising about eight days later than the maxima.

From February 6th (near Cairo, lat. 30°·5′ N) till March 1st (twenty-four miles south of Luxor, lat. 25°·58′ N) the minima varied between 33°·1 and 49°·8, but on March 1st the minimum temperature rose to 52°·8. After that date it oscillated between 45°·2 and 61°·8 (three observations omitted) till March 19th, when the observations came to an end at Asyoot, lat. 27°·9′ N., from whence I took the train back to Cairo, the extreme point south at which observations were taken being Assouan in lat. 24°·10′ N.

Moisture.—We were travelling across an exceedingly dry country, where rain seldom falls and the sun shines through a very clear sky. The river Nile, however, is the source of a considerable amount of moisture, as may be readily inferred from the luxuriant state of the crops raised. The wheat was nearly ripe in March, and the juicy sugar cane fell under the scythe of the reaper to be sent to the nearest sugar factory. This river action extends in some places to a considerable distance on its sides, such as at least six miles towards the Temple of Abydus, but in general the moist belt is narrower; it stands to reason that the atmosphere above the Nile and the irrigated districts must be damper than in the dry parched desert.

On February 5th in the morning, having left Cairo on the previous evening, there was a fog at sunrise over the river, which rose about 8 a.m. At 11 a.m. in our cabin the thermometers read, dry bulb 58°·0, wet bulb 53°·0, difference 5°·0; the air was calm and the day beautiful. February 6th was again foggy in the early morning, and fogs appear to be frequent along the track of the Nile up to about the latitude of Kenneh, say 26°·37′ N. On February 24th, twenty miles south of Asyoot, which is in lat. 27°·9′ N, a fog rose from the South at 6 p.m., while to the North the air was perfectly clear. There was much moisture in the air, at 8.40 p.m. the difference between the dry and wet bulb thermometers being 5°·4, although the fog had by that time disappeared. My dragoman informed me that there was a fog on the Nile every morning in this neighbourhood, which probably means they are of frequent occurrence.

From Luxor to Assouan the atmospheric humidity fell below the figures registered further North, but it continued low as we proceeded to Asyoot north of Luxor, on our way back; this, however, was apparently owing to a strong dry North wind, which never left us for the last four days before reaching Asyoot. The following were our greatest differences between dry and wet bulb thermometers, indicating the lowest records for Relative Humidity:—

March 6th, on board steamer, about twelve miles south of Luxor, lat. 25°·39′, N	° 28·4	Dry Northerly breeze blowing.
March 8th, Assouan, lat. 24°·10′	24·8	
,, 9th ,, ,, ,,	20·7	
,, 13th, Kenneh, ,, 26°·37′	21·6	
,, 16th, Farshout, ,, 26°·12′	20·3	Cold Northerly wind.
,, 17th (Max. temp. 78°·6)	18·0	From lat. 26°·12′ to 27°·9′ N. Strong, dry, and very cold Northerly wind blowing.
,, 18th (,, ,, 67°·8)	13·3	
,, 19th (,, ,, 69°·2)	14·9	

The readings for the differences between the dry and wet bulb thermometers on board the steamer from Luxor to Assouan may have been a trifle too high, as the thermometers were not so well sheltered from radiation as on board the dahabeeyeh, but I think the error was but slight. The bitterly keen sensation of cold on the 16th, 17th, 18th and 19th was remarkable, considering that the readings of the maximum thermometer varied on those days from 85°·4 to 69°·2. No great coat could keep out the cold, which was clearly due to the dryness of the air on those four days.

I cannot even give an idea of the frequency of rainfall at Luxor. We had a slight shower there one evening, and another heavier fall of rain the next night. This followed a gale from the North, driving up masses of dark clouds and blowing about the dust to such an extent that it was literally but just possible to breathe in it; and people were seen rushing to the river-side to escape the dust, as the wind blew across the river.

Luxor, from its greater atmospheric dryness, appears to be better suited for consumptive invalids than Cairo. The hotel at that place has a large garden in which roses and tropical plants grow. The building is in no way luxurious, but affords all the desired comfort; and there is a constant stream of visitors through it during the winter season. It is, I understand, under the management of Mr. Cook.

Observations for Radiation.—It occurred to me that a few observations on nocturnal radiation might be of interest where so much heat is absorbed throughout the day-time and given out at night under an all but constantly clear sky. On the Mediterranean coast of the Riviera, as soon as the sun has set a well-known chilly sensation is experienced, and the temperature undergoes a fairly regular fall for about an hour or an hour and a half. After that period it continues to subside in an irregular way, the progress of the fall being occasionally arrested, when a temporary rise of temperature may occur. These accessions of heat are I might say always accompanied by a drying up of the atmosphere.[1]

On the Nile in the neighbourhood of Luxor, lat. 25°·39′ N, where the following observations were made, the temperature in March commences to fall at sunset from 75°·0 or 80°·0, while on the Riviera it begins to subside from 54°·0 or 55°·0. Three hours after sunset at Luxor the temperature is lower than at sunset by 17° or 18°—these figures having actually been observed. On the Riviera, at Cannes, on March 15th, 1877, in the first three hours (less five minutes) after sunset I recorded a fall of temperature of only from 54°·0 to 49°·4, or 4°·6; on March 21st from 54°·0 to 49°·6, or 4°·4; on February 18th from 55°·0 to 48°·0, or 7°·0; from which it follows that the loss of heat from radiation is three or four times as great in Upper Egypt as in the Riviera during the three hours which follow sunset. The mass of heat given out in Upper Egypt and the Soudan on its way through the air keeps it warm, and it is only when the atmospheric temperature has reached about 65°·0, after sunset, in perfectly calm weather, that a cool

[1] *Quarterly Journal*, Vol. III. p. 473.

sensation begins to be experienced. I also believe, although I am conscious of treading here on disputed ground, that the increase of humidity after sunset attending the fall of temperature of the atmosphere is one of the reasons which account for the body being unconscious, or nearly so, of a cooling of the air by 10°. This accession of moisture produces a sensation of warmth by checking the evaporation from the skin and lungs.

The dryness of the air in the high winter health resorts in Switzerland is considered by some authors to keep the body warm while out at night, on account of the lessened power of dry air in conducting heat; but I might remark that at those stations there is a rapid and considerable accession of humidity after sunset, so that the air at night cannot be considered as particularly dry. Other reasons appear to me to militate against this view.

Experiment I. for Radiation.—The following observations were made on March 2nd, four miles south of Luxor, on which day the maximum in the shade was 78°·8. The thermometer readings were recorded every ten minutes from sunset at 5.50 p.m. (Cairo time) to 9 p.m. Three thermometers were under observation—dry and wet bulb thermometers hanging to the rigging of the boat above the upper deck and fully exposed to radiation, while another thermometer was simply laid on a wooden table and otherwise fully exposed to the air:—

Time.	Temperature Of air.	On table.	Difference.	Remarks.
p.m.	°	°	°	
5.50	74·2	66·8	7·4	Air feels warm, *i.e.* free from chill. We are tracking close to an earthen cliff about 20 ft high.
6.0	72·4	65·3	7·1	
6.10	70·2	64·1	6·1	
6.20	68·8	61·3	7·5	
6.30	67·0	60·3	6·7	First sensation of coolness, slight Westerly breeze rising.
6.40	70·6	67·3	3·3	
6.50	71·1	68·2	2·9	Air feels suddenly warmer, is quite calm.
7.0	71·5	69·2	2·3	
7.10	69·7	64·3	5·4	
7.20	67·4	62·8	4·6	Heat continues to be felt, but a slight cool draught from West rising.
7.30	64·3	59·3	5·0	Cooler.
7.40	64·3	59·1	5·2	
8.0	63·0	57·3	5·7	Cooler yet.
8.10	62·5	57·3	5·2	
8.20	60·7	54·3	6·4	
8.30	59·8	55·3	4·5	
8.40	58·0	53·8	4·2	Decidedly cooler.
8.50	57·1	52·8	4·3	
9.0	57·1	52·8	4·3	Chilly.

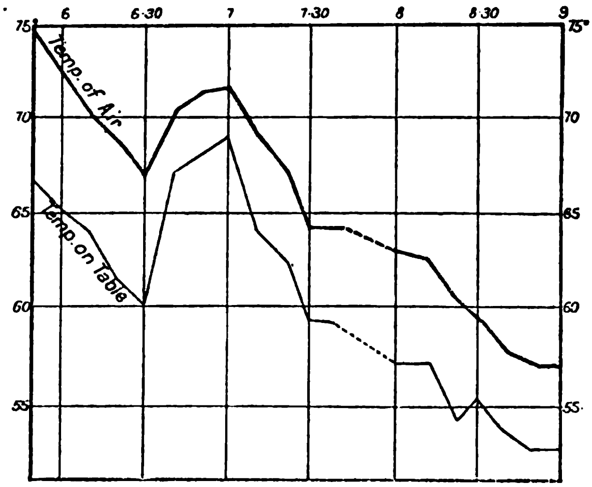


FIG. 1.—March 2nd, 1885.

Let us understand the meaning of the indications given by these two dry bulb thermometers. One of them is freely exposed to the air hanging to a line carried horizontally a few feet above the upper deck and about thirteen feet from the level of the river; although supplied with a wooden scale it shows the temperature of the air at that height above the Nile; had the thermometer been graduated on the tube with no attached scale the results might have been more satisfactory, but this instrument can I think safely be considered as showing the temperature of air, the wooden scale from its small size also taking the atmospheric temperature. The other thermometer shows the temperature of a large wooden terrestrial object—a table—or of the air immediately in contact with it; this object radiated its heat very freely under the fine clear sky, and therefore became, I may say, considerably colder than the atmosphere.

The following is a short analysis of these observations:—From 5.50 to 6.30 p.m., or in the course of forty minutes, the temperature of the air had fallen from 74°·2 to 67°·0, or by 7°·2, when a Westerly draught was felt, attended with a slight sensation of coolness. Then suddenly the temperature of the air rose by 3°·6, and that on the table by 7°·0. The thermometers continued rising slightly throughout the following twenty minutes, and then resumed their falling progress, until at 9 p.m. the readings were 57°·1 in the air and 52°·8 on the table. The oscillations of the temperature are clearly seen in the diagram.

The wet bulb thermometer had unfortunately to be exposed to radiation as well as the dry bulb, the two instruments being fixed on the same scale. They gave therefore differences for moisture-readings decidedly too high, although I believe in a condition to compare fairly with each other.

Time.	Dry Bulb.	Wet Bulb.	Vapour Tension.	Relative Humidity.	Time.	Dry Bulb.	Wet Bulb.	Vapour Tension.	Relative Humidity
p.m.	°	°	in.	o/o	p.m.	°	°	in.	o/o
6.10	70·2	59·4	·375	51	7.20	67·4	56·2	·325	48
6.20	68·8	60·7	·424	60	7.30	64·3	58·0	·399	66
6.30	67·0	56·2	·330	50	7.40	64·3	57·1	·375	62
6.40	70·6	52·6	·236	32	8·0	68·0	58·0	·413	72
6.50	71·1	51·7	·220	29	8.30	59·8	53·5	·334	65
7.0	71·5	52·6	·231	30	9.0	57·1	50·8	·299	64
7.10	69·7	54·4	·273	38					

Thus, as the temperature rose, the air dried up, the difference between the dry and wet bulbs having increased from 8°·1 at 6.20 p.m. and 10°·8 at 6.30 p.m. to 18°·0 at 6.40 p.m. and 19°·4 at 6.50 p.m. After 7.12 p.m. the temperature fell from 69°·7 to 57°·1 at 9 p.m., at the same time the air became much damper, showing a difference of only 6°·3 between the dry and wet bulb readings.

Experiment II. for Radiation.—On March 11th, twenty-two miles north of Luxor, the maximum temperature during the day was 85°·6. Our dahabeeyeh was moored alongside a bank about the height of our upper deck at ten yards distance. The experiment in other respects was carried out very much under the same conditions as the last, the evening was perfectly calm and the sky quite clear. The dry and wet bulb thermometers were exposed to the air, being hung up to one of the iron upright stanchions of the awning, which awning had been removed. I believe this arrangement was subsequently altered, and the thermometers were suspended to a horizontal line stretched across the upper deck; of this, however, I have no record in my notes. The other thermometer was laid on the table on the upper deck with no shelter from radiation. The following were the readings of the two dry bulb thermometers, which have also been shown in the form of a tracing:—

Time.	Temperature Of air.	Temperature On table.	Difference.	Time.	Temperature Of air.	Temperature On table.	Difference.
p.m.	°	°	°	p.m.	°	°	°
5.50	80·5	—	—	7.30	69·7	65·6	4·1
6.0	79·6	76·2	3·4	7.40	70·6	66·3	4·3
6.10	79·6	74·6	5·0	7.50	67·4	62·8	4·6
6.20	76·0	72·4	3·6	8.0	67·0	60·3	6·7
6.30	72·4	68·2	4·2	8.10	64·3	58·3	6·0
6.40	72·4	67·3	5·1	8.20	64·3	57·3	7·0
6.50	72·4	67·3	5·1	8.30	64·3	56·7	7·6
7.0	72·4	68·2	4·2	8.40	63·9	55·8	8·1
7.10	69·2	—	—	8.50	64·3	57·3	7·0
7.20	68·8	64·6	4·2	9.0	64·3	56·9	7·4

A rise of the temperature of the air therefore took place from 7.20 p.m. to 7.40 p.m., ranging from 68°·8 first to 69°·7 and then to 70°·6, the rise of

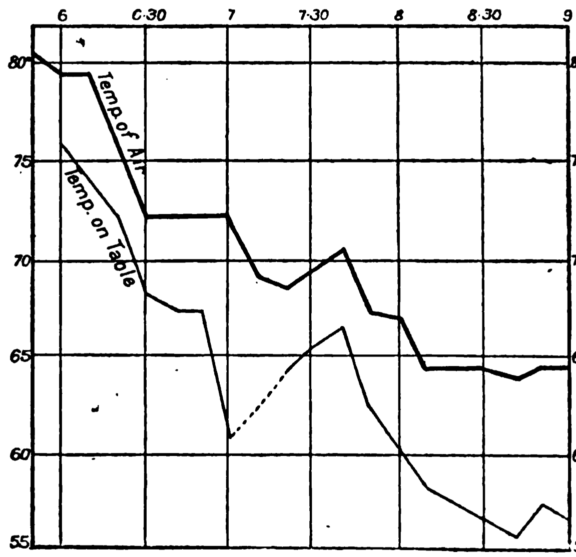


Fig. 2.—March 11th, 1885.

1°·8 being quite regular in its progress. The thermometer on the table indicated an increase of temperature on three different occasions—from 6.50 p.m. to 7 p.m., from 7.20 p.m. to 7.40 p.m., and a slight rise from 8.40 p.m. to 8.50 p.m. On the first occasion the access of heat was 0°·9, on the second 1°·7, and on the third 1°·5. This is clearly seen in the diagram.

In this second experiment the rise of the temperature of the air was also attended with an increase of atmospheric dryness, in accordance with the following readings :—

p.m.	Vapour Tension. in.	Relative Humidity. o/o	
7.0	·825	41	
7.20	·815	45	Temperature of air has fallen or remained stationary till 7.20, and then commences rising.
7.30	·301	41	Temperature of air continues rising.
7.40	·302	40	,, has attained its highest point.
7.50	·296	44	,, falling.
8.0	·309	47	,, ,,

The temperature of radiation on the table when rising was equally attended with an increase of atmospheric dryness :—

		°	
First rise of temperature.	6.40 p.m.	11·7	Temperature falling since sunset.
	6.50	14·4	Same temperature as at 6.40 p.m. (humidity increased before temperature actually rose).
	7.0	14·4	Temperature risen by 0°·9.

Second rise of temperature.	7.10	18°·0	Temperature falling.
	7.20	12·6	„ has continued falling to 7.20 p.m.
	7.30	13·9	Temperature risen since 7.20 p.m.
	7.40	14·4	„ continued rising, increased 1°·7.
Third rise of temperature.	8.20	6·3	„ fell 9°·0 since 7.40 p.m.
	8.30	6·3	„ continues falling.
	8.40	5·9	„ „
	8.50	4·5	„ risen 1°·5. (Dew deposited on glass.)
	9.0	6·3	„ fallen slightly.

At 8.50 p.m. dew was deposited on a magnifying glass left on the table, the air felt somewhat cooler, no wind. The increase of atmospheric dryness at 9 p.m. took place shortly after the rise of temperature had ceased, by which time the thermometer was falling slightly.

Experiment III. for Radiation. On March 15th near Ekhmeen, lat. 26°·32′ N, the maximum temperature under screen had been 86°·6. The dry and wet bulb thermometers were hung up to a horizontal line above the upper deck, and the other thermometer was laid on the table exposed to radiation. The sky was cloudy at sunset and somewhat later, but at 8.40 p.m. had cleared up. There was still, however, some haze, as the smaller stars were barely visible, no moon, air calm. The following were the readings recorded :—

Time.	Temperature Of air.	On table.	Difference.	Remarks.
	°	°	°	
6.45 p.m.	73·8	73·2	0·6	
7.0	78·3	70·2	8·1	Light Southerly breeze rising.
7.25	71·5	66·3	5·2	
7.40	72·4	67·7	4·7	Calm.
8.0	71·5	65·8	5·7	
8.20	68·8	65·3	3·5	
8.40	71·1	67·3	3·8	
9.0	65·2	61·3	3·9	

In this series of observations the temperature of the air is seen to increase on two occasions,—from 7.25 p.m. to 7.40 p.m. and from 8.20 p.m. to 8.40 p.m.,—the first rise is only 0°·9, and the second amounts to 2°·3. It is remarkable that the second rise took place just at the time when the atmosphere was clearing up. The thermometer on the table shows a corresponding increase of temperature. The wet bulb thermometer readings record but a slight increase of atmospheric dryness on these different occasions.

From the above observations there can be no doubt that accessions of dry heat take place occasionally after sunset on the Nile. I account for this phenomenon in the following way :—The course of the Nile and its cultivated

shores produce a track of damp air limited on both sides by the very dry air of the desert. As the temperature of the air on land falls from radiation after sunset, it approaches nearer and nearer to the temperature of the water of the Nile, and becomes relatively heavier. The damp air over the Nile being now lighter in comparison with the air on land, commences an ascending movement, spreading as it reaches a certain altitude and checking radiation underneath, when the thermometer will begin to rise. This accession of temperature is also due to heat from the desert attracted towards the river by the ascending current of damp air, hence the humidity will be lessened at the same time as the air is warmed. I can find no other explanation of this phenomenon, such as accessions of heat from banks or mountains, as at the time of these observations we did not happen to be near hills or very high banks. The first experiment was made under way shortly before our arrival at Luxor, which we reached at 10 p.m.; we were punting for want of wind, the banks were not particularly high, and the country beyond was flat. On the occasion of the second experiment we had brought up alongside a bank for the night, but the rise of temperature occurred an hour and a quarter afterwards, when the bank may well be considered as having lost any excess of heat absorbed.

The Temperature of the Water of the Nile.—The temperature of the water of the Nile was taken either by testing it in a bucket immediately after it had been procured, or by reading the thermometer held while its bulb was immersed in the water. The object was an attempt to ascertain the amount of heat absorbed during the day and given out at night; the temperatures were therefore taken just before or at sunrise and at sunset. A question arose as to whether the temperature of the surface water actually represented that of the whole bulk of the river. I tried by lowering a lightly corked bottle, and pulling out the cork with a string at various depths, to obtain samples of water near the bottom of the stream, but there was so much difficulty in carrying this out that no result was obtained. I have come to the conclusion that the river, with a stream of nearly a mile and a half per hour, though at places some thirty feet deep in March, and in others I believe deeper still, winds to such an extent, and has such an uneven bed, that there are many eddies and up and down currents mixing the water thoroughly, so that its temperature must be nearly the same throughout.

The readings were taken between Asyoot and Edfou, or between lat. 27°·9′ N and 24°·59′ N. At first I made the following daily observations without much reference to any particular time:—

Date and Place.	Temperature of Nile.	Air temperature. Maximum.	Air temperature. Minimum.
	°	°	°
February 26th, 4.35 p.m. (Gebel Heredee)	65·3	78·8	46·9
,, 27th, 10.45 am. (Soohag)	64·3	72·8	48·3
March 2nd, 5 p.m. (Luxor)	68·7	78·8	45·2
,, 3rd, 4 p.m. (Luxor)	67·3	82·8	—
,, 7th, 4.50 p.m. (Silsileh)	69·2	86·8	—
,, 10th, 10 a.m. (Edfou)	66·3	85·6	—

I now instituted the next series of observations, which were made at sunrise and sunset:—

March.	Temperature of Nile.				Air Temperature.		
	At Sunrise.	At Sunset.	Gain in Daytime.	Loss at Night.	Max.	Min.	Mean.
	°	°	°	°	°	°	°
11	..	69·2	..	..	85·6	46·2	65·9
12	66·1	69·2	3·1	3·1	84·3	52·3	68·3
13	68·0	69·2	1·2	1·2	88·5	54·4	71·5
14	68·2	70·4	2·2	1·0	85·6	57·5	71·5
15	69·2	71·2	2·0	1·2	95·7	..	..
16	70·2	70·8	0·6	1·0	83·3	55·7	69·5
17	68·2	68·2	0·0	2·6	78·6	57·5	68·1
18	66·3	66·3	0·0	1·9	69·8	48·2	59·0
19	64·3	66·3	2·0	2·0	69·2	43·6	56·4

These observations show that the mean of the observed temperatures of the Nile (68°·8) is a little higher than the corresponding mean temperature of the air (66°·8, mean of maxima and minima). Such a large body of water coming from tropical regions might have been expected to be warmer, but the present observations, few as they are, show that it is greatly affected by the temperature of the air. Thus on the 17th, 18th and 19th, our last three days before reaching Asyoot on our return journey; as already stated, a bitterly cold Northerly wind blew, lowering the maxima readings to 78°·6, 69°·8, and 69°·2 respectively; at the same time the temperature of the Nile fell from 70°·8 to 68°·2, 66°·3, and 66°·3. That cold wind was probably felt at a considerable distance up the river. It was a dry wind, and the rapid evaporation it must have caused at the surface of the Nile no doubt added not a little to its cooling influence.

Winds.—With reference to the winds, a Southerly gale rose in the night of February 13th to 14th, blowing very hard on the morning of the 14th. At 1 p.m. the gale (Khamseen) was at its height. To windward, in the South up the Nile, there is a gray mist of sand, while on the opposite side to us, or western shore, dry land can only be seen close to the river, every thing further off disappears in a cloud of sand. At 1.0 p.m. the other side of the Nile vanishes entirely, and reappears in rapid succession. Men and two donkeys on the opposite river side are seen off and on, looking much magnified, a curious circumstance as the phenomenon looked as if produced by fog, though there was no moisture in the air. At 3.55 p.m. the wind shifted to North-north-west, and by that time its force had abated; at 3.18 we had got under way.

An interesting phenomenon we witnessed in connection with the wind was its tendency to blow hard in places where the river skirts high chains of hills. There is a spot near the Arabian mountains called Gebel Aboufaydah, which is held in awe by boatmen on account of the squalls so frequent in that place. We were nearly getting into trouble there ourselves, being blown against the rocks, which fortunately sheltered us from the violence of the wind, but we actually came in contact with the limestone cliff.

The explanation of this phenomenon is obvious—the rocks become heated by the sun, and in the afternoon they cause a column of damp air to rise from the river; the vacuum thus produced is filled up by air rushing in from every direction, giving rise to squalls from the different points of the compass. The danger is known to be very much less in the morning than in the afternoon, which quite agrees with the present explanation, as the sun has not had time to heat the rocks before it has passed the meridian.

We witnessed on one occasion a moving column of sand; it crossed the Nile from West to East, about thirty yards from us. I saw it as it was reaching the eastern shore, where it became stationary, looking like smoke rising vertically from a fire; it then quickly disappeared. The atmosphere over our boat was then perfectly calm.

Sunsets were at times very beautiful, twilight lasting for an hour, or from several observations I concluded that between actual sunset and the disappearance of the last signs of redness in the western horizon, when darkness had set in, from fifty-five minutes to an hour and ten minutes had elapsed; but there remained for a long time after dark a peculiar brightness in the west, where the obscurity was not so deep as on the eastern horizon.

DISCUSSION.

Dr. WILLIAMS said, that Dr. Marcet in his journey up the Nile had taken the same route as that taken by invalids, and the observations he had made would be extremely useful to medical men, since they would be able to learn from them what weather was usually experienced by persons travelling there for the benefit of their health during the winter season. He was aware that the air of Egypt was very dry, but was surprised that the differences between the dry and wet bulb thermometers should have been so great as those quoted by Dr. Marcet. The greatest difference appears to have been 23° F.; but in the Red Sea a difference of even 40° F. was noted by Dr. Carpenter. With respect to the rapid fall of temperature after sunset, caused by the great amount of radiation, he had known patients to complain of being very cold at night, so great was the change. Still, Dr. Marcet's observations showed that the Nile itself exercised some equalising influence, especially at night. It would perhaps be thought that such changes would not be suitable for invalids; but it was found that the dryness of the air, to a great extent, prevented any injurious effects. He had noticed that in warm climates it was necessary to have a cold period, as a climate like that of Madeira, which was warm and very equable, did not suit pulmonary invalids nearly so well as those of the Riviera and Egypt, where there were considerable extremes of temperature. He had made an analysis of the cases which had come under his own and his father's notice of invalids who had been sent to the Riviera and to Egypt, and had found that the cases sent to Egypt were the most successful, though he must admit the numbers were small.

Mr. BALDWIN LATHAM thought the paper was very interesting and valuable. With respect to the rapid decrease of temperature at night it must be remembered that there was one other very favourable condition, and that was the temperature of the water of the Nile, the warmth from which would, to some extent, counteract the influence of the lower temperature of the air.

Dr. MARCET in reply said that the excessive atmospheric dryness shown by the readings of the dry and wet bulb thermometers was not the rule, but only occasional. Early mornings were damp, the air being often at sunrise nearly saturated with moisture. With reference to the fall of temperature in the evening, he had experienced no chilliness in Upper Egypt till three or four hours after sunset, which he ascribed not to deficient radiation but to the enormous amount of heat absorbed during the day-time and given out after sunset. At Cairo and some distance to the south of that town a chilly sensation was often felt after sunset.

THE MEAN DIRECTION OF CIRRUS CLOUDS OVER EUROPE. By DR. HUGO HILDEBRAND HILDEBRANDSSON, Hon.Mem.R.Met.Soc. (Plate X.)

[Read June 17th, 1885.]

THE researches into the movements of upper clouds have led to many valuable results for the study of storms. It seems also that such observations will be of great use in the forecasting of weather. Yet no attempt has been made to employ these observations for the calculation of the mean direction of the upper currents of the atmosphere. In my *Atlas des Mouvements supérieurs de l'Atmosphère* (Stockholm, 1877), I have calculated the mean direction of upper clouds for the whole year for many stations in Europe, and I found that this lay between North-west and South-west. As the mean gradient for the year dipped from the interior of the continent towards the ocean, the upper currents of course diverged from the area of lower pressure as they do in individual storms.

Yet the result deduced seems doubtful. The Rev. W. Clement Ley and I have both proved that the upper clouds are much more frequent in certain currents, especially the Southerly and Westerly, than in others. In the Easterly currents in the higher strata of the atmosphere cirrus clouds are very rare indeed. Of course in the means the component from some westerly point must make itself noticeable.

In a recent publication[1] I have calculated for Upsala and other stations in the middle of Sweden the mean directions of upper clouds for different gradients round about the centres of cyclones and anticyclones. The results are given in the tables on p. 288.

Thus the upper currents round a cyclonic area have a resultant movement from West, or about in the mean direction of storm-centres travelling over Upsala. The resultant current over an anticyclonic area comes from a little more northerly quarter, or about from West-north-west or North-west.

In a remarkable Paper,[2] the Rev. W. Clement Ley has also calculated the mean angles of the upper currents with the radius for separate areas round the centre, one of the diameters coinciding with the trajectory. (See Column II. of Table I. on p. 441, Vol. III.) Taking the resultant direction of these numbers, we obtain a resultant movement making an angle of only 12° with the trajectory of the centre; *e.g.* the centre travelling from West to East, the resultant direction is W 12° S.

Of course we find for Sweden as well as for England that the system of upper currents above a depression has a resultant direction coinciding almost with the trajectory of the centre.

Thus the direction of upper currents in the atmosphere is generally

[1] Sur la Distribution des Elements météorologiques autour des Minima et des Maxima barométriques. *Acta Soc. Reg. Scient. Upsal.* 1883.

[2] The Relation of the upper and under Currents of the Atmosphere around Areas of Barometric Depression. *Quarterly Journal of the Meteorological Society*, Vol. III. 1877.

TABLE I.—DIRECTION OF CIRRUS (WINTER).

Grad.	Below 745 mm.	Between 745—755 mm.	Between 755—760 mm.	Between 760—765 mm.	Above 765 mm.
N	W 12° 23′ N	W 22° 29′ N	W 36° 4′ N	N 39° 19′ W	N 31° 28′ W
NW	W 10 17 S	W 4 3 S	W 4 45 N	W 2 6 N	W 40 45 N
W	W 37 53 S	W 41 11 S	W 10 11 S	W 18 12 S	W 17 56 S
SW	S 42 10 E	S 28 48 W	S 35 0 W	W 27 57 S	S 14 41 W
S	E 25 40 S	E 18 6 S	S 26 49 E	S 20 26 E	E 21 35 S
SE	N 41 42 W	W 21 37 N	E 11 53 N	E 4 52 S	E 12 46 S
E	N 31 16 W	N 0 2 E	N 0 19 W	N 1 22 W	N 38 50 E
NE	W 42 33 N	N 41 53 W	N 23 30 W	N 22 0 W	N 6 57 W

TABLE II.—DIRECTION OF CIRRUS (SUMMER).

Grad.	Below 745 mm.	Between 745—755 mm.	Between 755—760 mm.	Between 760—765 mm.	Above 765 mm.
N	W 19° 35′ N	W 15° 28′ N	W 27° 35′ N	W 25° 51′ N	N 28° 14′ W
NW	W 19 38 S	W 12 52 S	W 11 30 S	W 4 5 N	W 24 52 N
W	S 32 12 W	W 44 0 S	W 40 11 S	W 18 56 S	W 5 54 S
SW	S 10 3 W	S 0 56 W	S 18 35 W	S 38 49 W	S 41 31 W
S	E 5 12 S	S 29 10 E	S 8 50 E	S 16 2 E	S 39 39 W
SE	E 30 2 N	E 12 37 N	E 2 14 N	E 3 50 N	E 7 39 N
E	N 45 0 W	N 13 1 W	N 19 48 E	N 12 55 E	N 42 55 E
NE	W 40 10 N	W 42 41 N	N 37 16 W	N 28 32 W	N 2 7 E

TABLE III.—DIRECTION OF CIRRUS (YEAR).

Grad.	Below 745 mm.	Between 745—755 mm.	Between 755—760 mm.	Between 760—765 mm.	Above 765 mm.
N	W 13° 52′ N	W 18° 36′ N	W 31° 40′ N	W 36° 7′ N	N 30° 16′ W
NW	W 14 35 S	W 10 10 S	W 7 34 S	W 3 24 N	W 33 34 N
W	W 42 0 S	W 43 33 S	W 36 49 S	W 18 46 S	W 10 38 S
SW	S 8 4 E	S 6 37 W	S 21 53 W	S 43 34 W	S 27 28 W
S	E 15 56 S	S 38 8 E	S 13 36 E	S 17 30 E	S 25 58 E
SE	N 4 33 W	E 25 58 N	E 7 7 N	E 1 55 N	N 0 21 E
E	N 33 27 W	N 5 4 W	N 9 6 E	N 7 0 E	N 41 8 E
NE	W 42 19 N	N 44 29 W	N 31 20 W	N 26 5 W	N 3 51 W

Taking the resultant directions, we have—

TABLE IV.

Zones.	Winter.	Summer.	Year.
Below 760 mm. (minimum)	W 7° 42′ N	W 11° 30′ S	W 2° 24′ S
Above 760 mm. (maximum)	W 42 12 N	W 23 24 N	W 31 0 N
Mean	W 16 54 N	W 3 24 N	W 10 54 N

speaking strongly modified by the different gradients at the surface of the earth, but on the whole the mean gradient existing at the level of the cirrus drives them from West to East.[1]

[1] See a Paper by Hann in *Oesterr. Zeitschr. f. Meteorologie*, 1879, p. 33; Supan: *Statistik der unteren Luftströmungen*, Leipzig, 1881, pp. 16, 17; van Bebber: *Typische Witterungs-Erscheinungen*, p. 24 (*Archiv. der Deutschen Seewarte*, 1882, No. 5).

As I have said before, there is little chance of obtaining the true mean directions of upper currents by calculating the mean directions of the cirrus clouds, because these clouds are more frequent in certain upper currents than in others; yet I have undertaken this labour. During the last ten years I have collected a vast number of observations on the directions of cirrus, kindly sent to me by a great number of observers from many parts of Europe. Considering that this collection is probably the greatest now existing, I have thought it worth while to take the means for each season. The results are given in the Tables V.-VIII., and in the charts Plate X. with the isobars for January, April, July and October, by M. Teisserenc-de-Bort.

TABLE V.—Mean Directions of Upper Currents (per thousand), WINTER.

Stations.	N.	NW.	W.	SW.	S.	SE.	E.	NE.	Mean.
Lapland	397	188	221	66	50	17	22	39	N 47·0° W
Norrland	233	260	197	155	28	21	14	92	W 40·2 N
Upsala	159	362	275	111	22	9	13	49	W 31·7 N
Svealand	255	290	243	61	38	24	40	49	W 44·7 N
Götaland	273	239	263	29	39	10	54	93	N 36·5 W
Sandön	241	374	125	54	45	9	9	143	N 31·0 W
Skåne	216	320	144	129	52	26	15	98	W 44·3 N
England	120	180	300	177	75	30	32	86	W 10·2 N
Paris	141	188	263	201	66	33	36	72	W 12·3 N
Austria	87	223	344	220	40	37	15	34	W 4·5 N
Pola and Lesina	191	165	258	148	64	30	51	93	W 28·3 N
Perpignan	46	571	215	43	15	35	40	35	W 35·9 N
Lisbon	61	194	246	267	103	52	40	37	W 12·3 S
San Fernando	100	194	301	107	30	54	174	40	W 24·0 N

TABLE VI.—Mean Directions of Upper Currents (per thousand), SPRING.

Stations.	N.	NW.	W.	SW.	S.	SE.	E.	NE.	Mean.
Lapland	332	287	217	61	45	29	16	12	N 44·0° W
Norrland	223	250	203	125	59	16	27	98	W 30·7 N
Upsala	137	261	231	165	96	28	22	59	W 15·5 N
Svealand	198	188	269	92	70	34	72	77	W 35·6 N
Götaland	254	192	161	116	85	42	54	93	N 41·2 W
Sandön	152	236	146	112	84	67	67	135	N 41·9 W
Skåne	146	205	158	217	102	47	26	99	W 12·4 N
England	104	179	214	164	112	72	71	83	W 1·9 N
Paris	122	165	253	205	109	38	53	56	W 0·2 S
Austria	55	135	340	289	100	29	12	41	W 14·2 S
Pola and Lesina	98	213	308	157	42	21	63	98	W 19·7 N
Perpignan	37	497	228	105	29	44	41	18	W 25·0 N
Lisbon	63	85	261	264	84	57	57	29	W 11·1 S
San Fernando	81	143	388	54	62	53	87	31	W 0·5 S

We find that the numbers in the tables and the arrows on the maps lead to the following results:—

1. The mean direction of upper currents at all stations lies between South-west and North-west.

2. There exists an annual period, viz. in winter the cirri come from a more Northerly direction, and in summer from a more Southerly.

3. The mean directions in Sweden differ but little from the results in Table IV.

TABLE VII.—MEAN DIRECTIONS OF UPPER CURRENTS (PER THOUSAND), SUMMER.

Stations.	N.	NW.	W.	SW.	S.	SE.	E.	NE.	Mean.
Lapland	211	319	221	63	88	25	13	60	W 38°·0 N
Norrland	81	178	198	279	158	45	20	40	W 19·0 S
Upsala	115	181	213	208	137	55	39	53	W 6·4 S
Svealand	111	153	289	174	110	58	54	52	W 2·7 S
Götaland	152	125	235	143	149	68	57	71	W 1·6 S
Sandön	144	255	157	124	85	85	52	98	W 33·5 N
Skåne	73	164	211	266	150	55	27	54	W 20·1 S
England	96	153	293	189	91	57	42	78	W 0·8 S
Paris	61	137	341	255	122	38	23	23	W 15·7 S
Austria	70	176	312	223	81	57	23	57	W 5·2 S
Pola and Lesina	80	296	304	116	44	44	36	80	W 21·8 N
Perpignan	30	378	323	163	22	25	31	27	W 14·0 N
Lisbon	87	182	215	367	94	18	15	22	W 13·3 S
San Fernando	44	124	500	142	31	27	97	35	W 0·8 N

TABLE VIII.—MEAN DIRECTION OF UPPER CURRENTS (PER THOUSAND), AUTUMN.

Stations.	N.	NW.	W.	SW.	S.	SE.	E.	NE.	Mean.
Lapland	298	313	244	38	46	15	0	46	N 43°·9 W
Norrland	114	255	234	213	142	21	7	14	W 0·3 S
Upsala	145	268	245	167	94	23	23	35	W 15·3 N
Svealand	163	231	282	145	71	34	39	35	W 18·4 N
Götaland	223	228	256	141	76	27	16	33	W 24·8 N
Sandön	104	260	271	94	94	31	83	63	W 21·9 N
Skåne	79	255	198	243	116	30	34	45	W 2·4 S
England	104	197	242	199	99	38	26	95	W 6·1 N
Paris	89	192	271	206	109	32	42	59	W 1·3 S
Austria	79	215	337	234	69	23	13	30	W 0·1 N
Pola and Lesina	126	229	285	196	42	38	47	37	W 12·7 N
Perpignan	26	447	268	145	14	38	26	36	W 20·2 N
Lisbon	71	181	238	310	108	35	19	38	W 13·9 S
San Fernando	68	166	407	104	59	50	101	45	W 6·4 N

4. In winter the Northerly component is greater on the Baltic and the northern border of the Mediterranean Sea.

5. Of course the mean directions of upper currents nearly coincide with the mean tracks of storm-centres.

6. The upper currents of the atmosphere tend in general to flow away from those areas in which a barometric depression exists at the earth's surface, towards those in which there is an elevation of pressure. The present maps show that this is also the case for the mean directions in three seasons, viz. winter, spring, and autumn, but not in summer. It is also evident that the relation between the mean direction of upper currents and the mean pressure at the surface of the earth cannot be the same as in the single storms. In the three first-named seasons the mean gradients dip towards some westerly point, the pressure in the interior of the Continent being high, and an almost continuous stream of depressions passing over the North-west of Europe. In summer the gradients are reversed, and are not so steep. Of course the depressions are shallower and not so frequent in Europe. Yet the Tables I. and II. show that the directions of upper currents

round a cyclonic or anticyclonic area in summer differ but little from the same directions in winter, and Table IV. shows that the mean direction is in both cases about the same.

7. From what is said above it follows as a practical rule for the publication of cloud observations that such observations must be published *in extenso*, as they have evidently their greatest value for the study of the dynamic meteorology.

Concerning Tables V.-VIII. it may finally be remarked: *Lapland* is the result of two stations, Qvickjock and Arjeploug; *Norrland* also of two, Hernösand and Sundsvall, both on the coast of the Gulf of Bothnia; *Svealand*, or the midland of Sweden, contains six stations, *Upsala* being taken by itself; *Götaland* one station, Skeppsholmen with complete observations for ten years, and several stations for shorter periods; *Sandön*, a sand island with lighthouse 55 kilometers North from Gothland, in the open sea (the result is doubtful, the observations being only 589 in all in the two last years, but they are very good and the situation in the Baltic excellent); *Skane* (Schonen, Scania), the extreme south of Sweden, with many stations for different years; *England*, continuous observations from Stonyhurst, and for different years from many stations, for which I wish to express my gratitude to the Rev. W. Clement Ley; *Paris*, many years from Mons. E. Renou, and a somewhat lesser series from the Observatory at Montsouris; *Austria*, many stations for several years from all parts of the Empire; *Pola and Lesina* are treated separately; *Perpignan*, observations published *in extenso* in "Bulletin Météorologique du Département des Pyrénées-Orientales since 1876; *Lisbon*, complete series from Capt. de Brito-Capello; *San Fernando* also complete series from Capt. C. Pujazon.

DISCUSSION.

Mr. ARCHIBALD said he was somewhat puzzled by a remark made in the paper, that "in the easterly currents of the higher strata of the atmosphere cirrus clouds are very rare indeed." He understood that the only way in which the direction of upper currents could be determined was by the motions of the cirrus, and if no cirrus clouds were seen moving from an easterly direction, it might be owing to the fact that Easterly upper currents were rare. There was no evidence in the paper to show that this might not be as legitimate an inference as that mentioned by the author, and besides it agreed with all that was known theoretically on the subject. He wished to draw attention to the fact that according to Dr. Sprung the relation of the wind to the isobars at high altitudes was different to that at the surface. At the surface the rotation in a cyclone was with watch-hands inwards towards the centre. At high elevations it was with watch-hands outwards from the centre. In judging of the gradient at high levels, therefore, which produced Westerly upper currents, account would have to be taken of this.

The PRESIDENT (Mr. Scott) said there was very little doubt in the minds of those who had to do with forecasting as to the value of cirrus observations, but the great difficulty was to obtain any reliable observations.

NOTE ON THE WEATHER OF JANUARY 1881. By CHARLES HARDING, F.R.Met.Soc.

[Read June 17th, 1885.]

THE Weather of January 1881 was of such an exceptional character over the British Islands, that probably no apology is needed for bringing one or two points of interest in connection with it before the Society at so long a period after date. Indeed, in any case where our own weather is dealt with in connection with conditions existing over the Atlantic, much time is necessarily occupied in the collection and the discussion of the material.

The features which rendered the weather of January 1881 of more than ordinary interest, were:—1. The frost, which was both prolonged and exceptionally severe; 2. The heavy gale of the 18th and 19th; and 3. The snow storms.

The first of these (the frost) was fully discussed by Mr. W. Marriott in a very able paper which was printed in the *Quarterly Journal*, Vol. VII. p. 188. The third (the snow storms) was discussed by Mr. H. Sowerby Wallis, and published in *Symons's Monthly Meteorological Magazine* for February and March 1881. This discussion included the snow storm which accompanied the gale of the 18th and 19th, but no detailed discussion has been made of the gale itself, although it was one of the most severe ever experienced in the British Islands, and for its destruction to life and property ranks high in the annals of English storms. The principal cause which rendered it so destructive was the barrier of high barometric pressure over Scandinavia, which obstructed the easterly passage of the depression, causing its centre to stand over the English Channel, and thus lengthen very considerably the period of the storm's duration within our area.

The normal condition of atmospheric pressure in January over the North Atlantic and the adjacent continents is shown in Fig. 1.[1] From this it is seen that in January there is usually an area of high pressure (30·3 ins.) in the Mid-Atlantic, and an area of low pressure (29·4 ins.) extending over the south of Greenland and the adjacent sea. This distribution of pressure would produce Westerly winds between the parallels of 40° and 60° N Lat. In the British Islands and the adjacent sea the trend of the isobars would require that the wind should be South-westerly. The diagram also indicates that there are also areas of relatively high pressure over the continents of Europe and America.

It is not difficult to find a January of late years in good agreement with the normal condition, indeed the years 1882, 1883, and 1884 have all been so to a very great extent. For purposes of comparison, January 1883 has been chosen, and Fig. 2[2] gives the isobaric lines. The distribution of pressure is very similar to that in Fig. 1, except that the high barometer

[1] Copied from *The Barometer Manual for the Use of Seamen*, published by the Meteorological Council, Plate I.

[2] Copied from the *Bulletin of International Meteorology*.

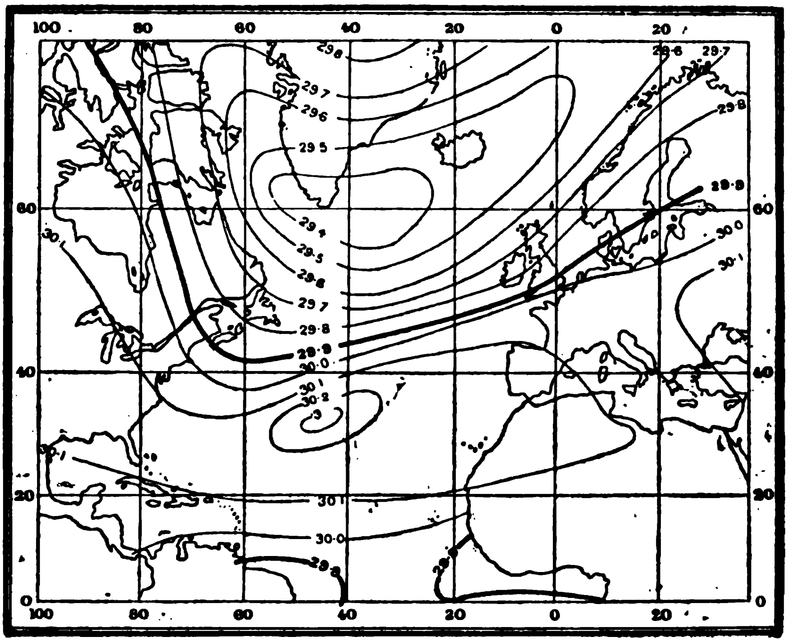


FIG. 1.—Mean Isobars for January.

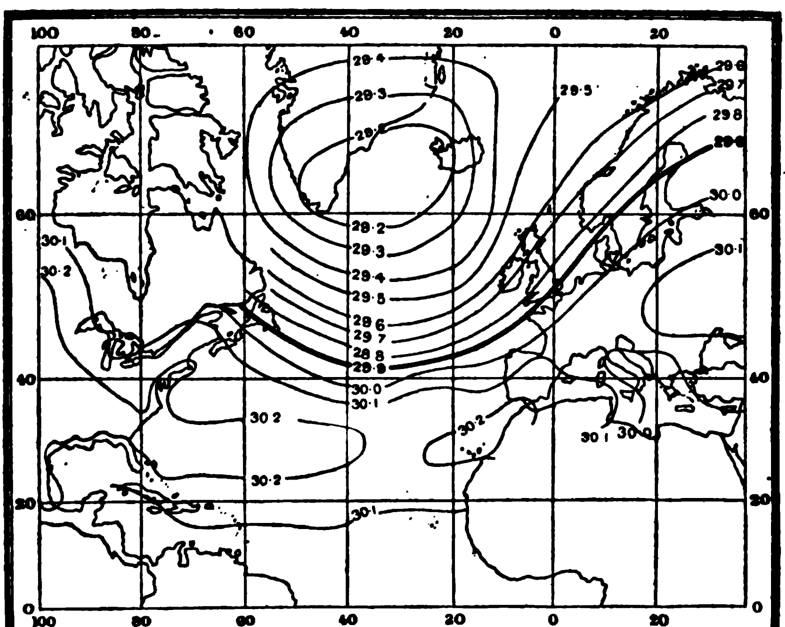


FIG. 2.—Isobars for January 1883.

(30·2 ins.) in Mid-Atlantic is less pronounced, whilst the low barometer (29·2 ins.), embracing the south of Greenland and part of Iceland, is more pronounced. The distribution of pressure shown in the Fig. is favourable for South-westerly winds in the British Islands and over Western Europe generally.

In January 1881 a very different state of affairs existed, as will be seen by Fig. 3.[1] This shows an almost entire reversal of average conditions. Instead of the area of high pressure in Mid-Atlantic there is an area of low barometer

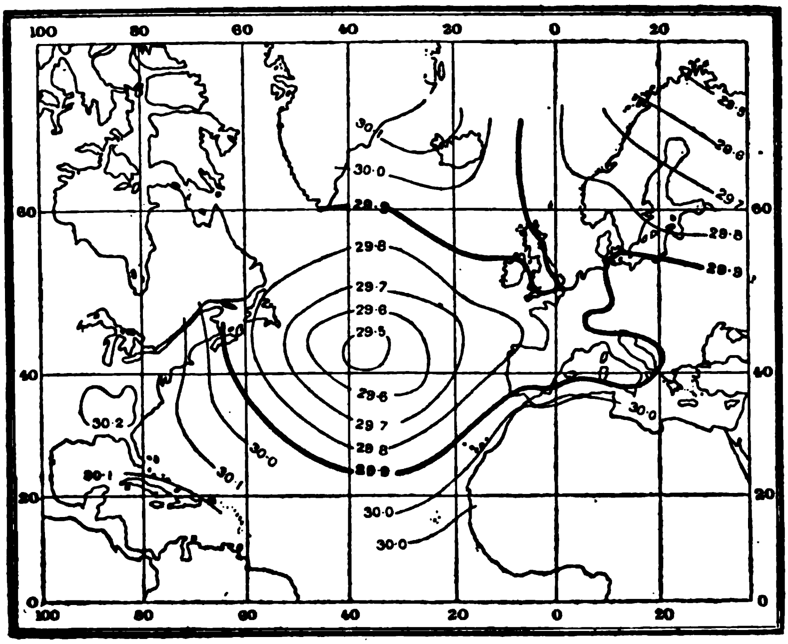


FIG. 3.—Isobars for January 1881.

(29·5 ins.), and instead of the low pressure area in the vicinity of Greenland and Iceland, there is an area of high barometer (30·1 ins.). This distribution of barometric pressure would give Easterly winds over the whole of the Atlantic between the parallels of 40° and 60° N Lat. A close examination of the Figures seems to indicate that in January 1881 the general barometric conditions were pushed nearly 20° further south than usual, this change of necessity influencing wind, temperature, and indeed all meteorological elements. Why so important a difference should have existed is not at all easy to explain. It is interesting to notice that in all three Diagrams the isobar of 29·9 ins. runs close to London, although in Fig. 3 it is the 29·9 ins. isobar on the northern side of the area of low pressure and not the southern 29·9 ins. as in Figs. 1 and 2.

Additional light is thrown upon the weather of the Northern Hemisphere in

[1] Copied from the *Bulletin of International Meteorology*.

January 1881 by an examination of the Synchronous Charts published by the late Captain Hoffmeyer. These Charts show that at the end of December 1880 the Atlantic high pressure area (30·5 ins.) was central to 45° N and 20° W, and low pressures were skirting to the North, the barometer being as low as 28 ins. on the south-west coast of Greenland. At this time the British Islands were experiencing Northerly Winds, owing to the Atlantic high pressure area being situated so far north. At the commencement of January the high pressure (30·5 ins.) advanced over Europe, and an area of low pressure took possession of the Mid-Atlantic. On January 6th the barometer was 30·7 ins. over the North Sea and Denmark, and in Mid-Atlantic it was 29 ins. On the 9th the highest pressure had extended to Iceland, and a large area of low pressure was still situated in Mid-Atlantic, which was influencing the weather over the whole ocean. To the north of the low pressure Easterly winds were blowing from Europe to Labrador and Newfoundland, and to the south, Westerly winds were blowing from America to Africa. This distribution of pressure continued until after the middle of the month; but towards the close, although the high pressure area held its position over Greenland and the higher parts of the North Atlantic, the barometer readings in Mid-Atlantic were in a chronic state of disorder, small patchy areas of low pressure being dotted here and there. Fig. 4 shows the position of the centres of low pressure for the entire month (obtained from Hoffmeyer's *Daily Synchronous Charts*), and also the tracks followed by these areas. The very southerly route taken by the depressions and the manner in which they hang in Mid-Atlantic are exceptional features, and although similar maps have been examined for periods extending over several years, so marked an instance has scarcely been met with. The track of the memorable storm of January 18th and 19th is well shown by a thick line on Fig. 4; it first becomes evident near New York on January 10th.

The frost of January 1881 lasted from the 7th to the 27th. The following quotations from the *Remarks on the Weather*, by Mr. Glaisher, give a very general idea of the prevailing conditions :—"The weather in January for the first few days was fine, but on the 7th a period of exceptionally bad weather set in, which was remarkable for its severity from the 12th to the 27th. Snow fell on every day from the 9th to the 27th, with the exception of the 25th; south of the latitude of 51° it fell on fourteen days, and in other parallels of latitude on from ten to thirteen days; on some days the fall was general. . . . ." "The mean temperature of the month at all stations north of 51° 25′, with the exception of Lowestoft and Llandudno, was below 32°."

Comparing January 1881 with the averages for 1857 to 1869 (see Charts given in Mr. Marriott's Paper), it is seen that January 1881 was colder than usual by 10° in Scotland and 9° in both England and Ireland.

January was also cold in 1879 and 1880, but the conditions associated with the weather were different in each of the three years. In January 1879 the cold came with well developed cyclonic conditions: low pressures were passing to the south of our Islands, but sufficiently close to bring the whole of the United Kingdom under the direct influence of their northern parts, so

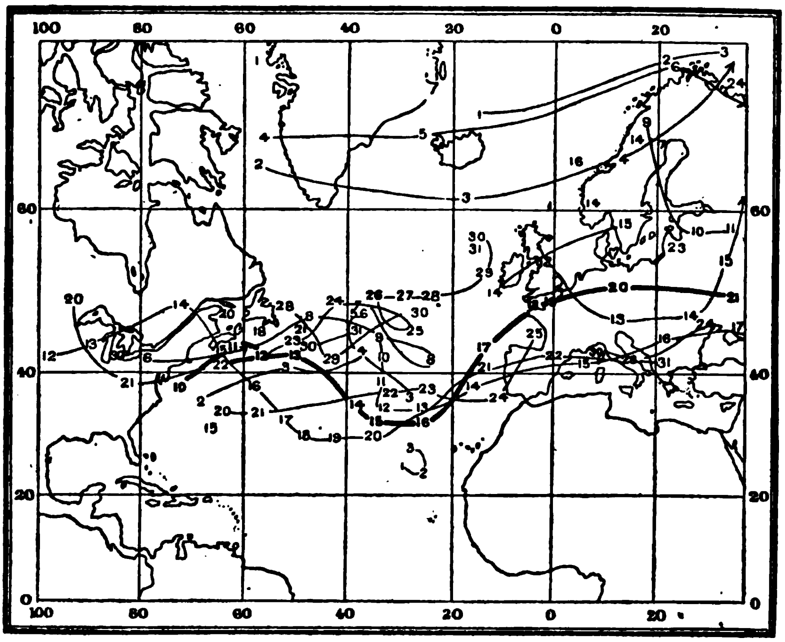


FIG. 4.—Tracks of Low Pressures for January 1881.
The figures show the positien of the low pressure for the several days. The track of storm for January 18th and 19th is shown by a thick line.

that strong Easterly and South-easterly winds were experienced. In 1880 the conditions were somewhat similar to those of 1881, inasmuch as they were decidedly anticyclonic, and a permanent area of low pressure was situated over the Atlantic; the high pressure was, however, nearer to the British Islands, at times quite embracing our area.

The following figures give the mean air temperature in January, deduced from hourly readings, for some of the principal observatories in the British Islands, for the three years 1879, 1880, and 1881:—

	1879.	1880.	1881.
	°	°	°
Aberdeen	33·5	38·1	29·4
Glasgow	31·3	38·0	29·2
Stonyhurst	30·6	34·8	29·8
Greenwich	31·8	33·3	31·7
Falmouth	39·1	41·2	37·6
Valencia	41·5	44·3	38·6

It will be seen that January 1881 was the coldest, and the next in order was January 1879; indeed it was only in England that January 1880 could be termed cold. At Greenwich, the mean temperature for the three Januarys was only 32°·3.

In order that the weather of January 1881 can be compared with that of the few following years, the following Table has been formed (the values

Station.	Lat.	Long.	Barometer. 1881.	Barometer. 1882.	Barometer. 1883.	Barometer. 1884.	Air Temperature. 1881.	Air Temperature. 1882.	Air Temperature. 1883.	Air Temperature. 1884.
	° ′	° ′	Ins.	Ins.	Ins.	Ins.	°	°	°	°
Godthaab ..	64 11 N	51 46 W	30·02	29·36	29·21	29·49	27·5	4·8	13·8	5·9
Stykkisholm	65 5 N	22 46 W	30·13	29·32	29·18	29·34	17·2	30·2	31·1	28·4
Thorshavn	62 2 N	6 44 W	29·87	29·67	29·56	29·52	34·3	41·5	41·0	38·1
Aberdeen ..	57 10 N	2 6 W	29·92	30·06	29·74	[1]29·73	31·1	42·8	40·3	[1]42
Glasgow	55 53 N	4 17 W	29·92	30·12	29·73	...	31·1	43·3	40·9	...
Greenwich ..	51 29 N	0 0	29·90	30·37	29·92	30·10	33·6	42·5	44·2	45·9
Vienna	48 12 N	16 22 E	29·99	30·56	30·16	30·19	25·9	35·6	31·6	43·9
Brussels	50 51 N	4 22 E	29·68	...	...	30·17	30·0	...	...	43·9
Lisbon	38 42 N	9 8 W	29·89	30·41	30·20	30·37	51·4	51·1	53·2	53·1
Angra	38 39 N	27 14 W	29·56	30·13	30·12	...	55·9	57·9	57·9	...
Funchal	32 38 N	16 55 W	29·93	30·27	30·24	30·30	65·5	64·0	65·3	63·3
Halifax	44 39 N	63 36 W	29·93	29·98	30·12	30·09	17·5	19·5	13·0	16·4
New York ..	40 43 N	74 0 W	30·15	30·18	30·22	30·17	22·9	28·0	25·9	23·5
Ocean data. Centre of 5° Squares.	42·5 N	32·5 W	29·53	30·12	29·85	30·08	54·1	53·7	53·5	57·4
	42·5 N	37·5 W	29·41	30·01	29·86	30·08	52·0	51·0	50·9	55·0
	47·5 N	32·5 W	29·54	29·87	29·58	29·89	50·4	47·3	46·3	50·9
	47·5 N	37·5 W	29·52	29·79	29·60	29·88	49·0	43·5	42·1	47·3

Station.	Wind Direction. 1881. N.	NW.	W.	SW.	S.	SE.	E.	NE.	Calm.	1882. N.	NW.	W.	SW.	S.	SE.	E.	NE.	Calm.
Gothaab	4	2	...	1	8	1	1	11	3	11	6	3	2	1	...	1	7	...
Stykkisholm	...	...	2	2	2	1	13	6	5	...	...	5	7	7	1	7	4	...
Thorshavn	11	...	4	3	...	1	1	8	3	...	4	9	9	4	1	...	1	3
Aberdeen	2	7	12	2	6	1	1	...	...	...	1	5	10	11	3	1	...	...
Glasgow	10	1	2	3	1	1	4	9	...	1	1	4	14	7	1	2	1	...
Greenwich	3	2	2	6	4	1	3	10	...	1	...	1	12	11	5	1	...	...
Vienna	4	2	10	...	...	10	...	...	5	1	10	4	1	...	3	...	1	11
Brussels	...	3	2	8	6	...	4	3	5	...	...	...	...	...	...	...	...	...
Lisbon	2	1	2	11	3	1	2	9	...	...	...	...	7	...	5	8	3	8
Angra	2	4	5	5	2	4	8	1	...	5	4	5	3	4	8	1	1	...
Funchal	...	...	11	11	4	1	2	1	1	18	1	...	...	...	1	2	9	...
Halifax	4	14	10	...	...	1	...	1	1	2	4	14	1	4	3	2	1	...
New York	8	9	7	3	1	...	1	2	...	...	5	9	9	...	...	4	4	...
Ocean data. Centre of 5° Squares.	Prevailing Wind SW.									...	4	3	14	9	1	...	...	...
	Do. NE.									...	11	4	11	4	1	...	...	...
	Do. SE.									...	3	7	15	4	2	...	...	...
	Do. NE.									...	8	8	8	4	1	...	...	...

Station.	Wind Direction. 1883. N.	NW.	W.	SW.	S.	SE.	E.	NE.	Calm.	1884. N.	NW.	W.	SW.	S.	SE.	E.	NE.	Calm.
Godthaab	11	7	...	1	1	...	1	10	...	9	4	...	1	1	4	...	12	...
Stykkisholm	...	...	...	...	6	9	5	10	1	...	1	1	11	...	4	7	6	1
Thorshavn	2	1	2	6	9	8	...	...	3	2	1	9	4	3	2	1	5	4
Aberdeen	...	1	3	7	11	9	...	...	...	[1]0	0	0	2	3	10	14	2	0
Glasgow	1	...	4	8	3	3	7	5	...	...	...	...	...	...	...	...	...	...
Greenwich	1	1	2	7	6	2	7	5	...	...	2	3	18	5	...	2	...	1
Vienna	3	3	4	1	...	10	2	1	7	...	5	16	1	1	3	...	1	4
Brussels	...	...	...	...	...	...	...	...	...	...	...	8	18	2	1	1	...	1
Lisbon	5	4	4	3	4	...	3	8	...	7	1	1	3	5	...	1	13	...
Angra	2	12	9	3	2	2	...	...	1	...	...	...	...	...	...	...	...	...
Funchal	1	1	3	11	...	10	5	...	...	4	...	1	4	...	7	9	4	2
Halifax	5	4	16	1	1	1	...	1	2	6	4	10	6	2	...	1	...	2
New York	4	1	7	2	2	2	1	7	5	2	4	8	5	2	1	...	7	2
Ocean data. Centre of 5° Squares.	2	10	6	13	...	...	...	...	...	1	6	11	6	3	1	2	1	...
	2	14	6	9	...	...	...	...	...	1	8	10	6	2	3	...	1	...
	1	11	8	9	...	2	...	...	...	2	7	11	5	4	1	...	...	1
	1	15	9	4	1	...	...	1	...	3	6	11	5	4	1	...	1	...

[1] The data at Aberdeen for 1884 are obtained from Observations published by the Meteorological Office.

being obtained from the several *Monthly Bulletins of International Meteorology*).

The Table shows how some elements vary, while others do not; and also how important differences are felt at some stations and not at others; for instance, in spite of the very different conditions prevailing over the Atlantic in the several years, the barometer and air temperature readings at Halifax and New York are similar. It will be seen that in January 1881 the barometer at Stykkisholm, in Iceland, was 0·57in. higher than at Angra, in the Azores; whilst in January 1883, the barometer was 0·94in. lower at Stykkisholm than at Angra, the variation in the two years amounting to 1·51in., which is equal to nearly ·01in. in every ten miles. The Table also shows important differences in the wind directions, there being an absence of warm equatorial winds in January 1881 at all the northernmost stations.

These comparisons point to the desirability of caution being used before conclusions are too hastily drawn from mean values, and show how misleading the mean values for a month may prove. In combining such periods as January 1881 and January 1883, we are throwing together conditions of quite an opposite character, and so most effectually masking all evidence of the existence of differences of material value. More attention should be paid to the homogeneous character of the weather for the purpose of averages, since the type of the weather, as for instance cyclonic or anti-cyclonic, exerts a very important influence.

The conditions which prevailed generally over the British Islands throughout 1884 and the early part of 1885 were exceptional, in so far as the weather was exceedingly dry, the temperature generally warm, and the winds very quiet. If a reason is sought for these exceptional conditions, we say that the cyclonic systems which form such an important factor of our English weather have taken a more northerly course than usual, and have passed either wholly to the north of the British Islands, or have occasionally passed across Scotland. In short, we have been much freer than usual from the passage of storm-centres over our Islands. But these causes are only secondary to others, and it is to the primary causes that we should look. The passage of low pressures is doubtless due to the relative distribution of high and low pressures, and when we speak of a general interruption to the track of depressions extending over a lengthy period, such as that through which we have recently passed, it means that in all probability the general distribution of atmospheric pressure over a very large surface of the earth has been abnormal; clearly this was so in January 1881, although probably just in the opposite direction. Why this should be so is a subject for inquiry, and one which if it could be solved would be of vast interest to the science of Meteorology.

DISCUSSION.

Mr. LAUGHTON thought that Mr. Archibald's remark as to cause and effect in the discussion on Dr. Woeikoff's Paper would very well apply in this case. The author of the Paper seemed to imply that the peculiar distribution of the isobars

was the cause of the abnormal weather in January 1881; but it might equally well be said that the weather was the cause of the distribution of the isobars; and very probably they were both due to some third cause. We seem, as yet, utterly in the dark as to what that cause may be, and we do not know even in what direction to look for it. He hoped that some day it might be discovered.

Mr. ARCHIBALD said that these movements of the dominant isobars were at present the great problem of Meteorology. Though they apparently underwent different phases, with some approach to regularity, according to season, they appeared occasionally to perform most abnormal movements. Thus he had seen it remarked that in the summer of 1879, the worst for several years, the mean distribution of pressure was similar to that in December of ordinary years.

THE PRESIDENT (Mr. Scott) thought that Mr. Harding had done great service in tabulating and working up this subject, and that the best thanks of the Society were due to him for his Paper.

ON THE INFLUENCE OF ACCUMULATIONS OF SNOW ON CLIMATE. By Dr. ALEXANDER WOEIKOF, Hon.Mem.R.Met.Soc.

[Read June 17th, 1885.]

THE accumulations of snow and ice on the high mountains of our globe in the shape of glaciers, &c. have attracted a great amount of study. I have often wondered why so little attention has been given to another subject, very important in its bearings—I refer to the sheet of snow which every winter covers immense tracts of the continents of Europe, Asia and North America, and every summer disappears. Can it be that this does not exert a great influence on climates as well as on other phenomena? The following remarks are intended to show that such an influence does exist, and that the subject well deserves study.

A covering of snow on the ground acts, firstly, as a bad conductor, rendering the interchange of temperatures between the surface of the ground and the lower stratum of the air much slower than when snow is absent. The reason of this is certainly to be found in the loose structure of the snow, which tends to the inclusion of air within the mass of snow. The structure of the snow is in this respect very important, the small crystals falling during cold weather being worse conductors than large flakes; and if the snow, by alternate thawing and freezing,[1] has the structure of *firn (névé)*, it is a far better conductor of heat. This influence of snow is well known to farmers in countries where the winters are cold; if the snow is deep enough they have no fear that the winter corn will be frozen. Thus the presence of snow on its surface undoubtedly produces a higher temperature of the upper strata of the ground, and, besides the structure of the snow, its depth is also very important.

We see that as a covering of snow protects the upper parts of the ground from radiation and makes the conduction of heat much slower than it would

[1] In the case of snow lying only in winter the pressure of the layer is not so great as to lead to the formation of *névé* (snow solidified into ice).

otherwise be, it thus tends to raise the temperature of the soil; but it must have a contrary influence on the lowest stratum of the air, as the snow protects it from the conduction of heat from the ground, an action which, as this is generally warmer in winter, must make the lowest stratum of the air colder. This it undoubtedly does; but in this respect another quality of the snow is even more important, its being a good radiator of heat. This is caused by the great extent of radiating surface which it presents, as well as by its white colour. In its capacity as a radiator the depth of snow is of no importance; it will act in a thorough manner if only it covers the ground in a continuous sheet, no matter how thin, provided it retains its feathery structure and is not converted into *névé*.

We know very well that if the air is rarefied it contains little of vapour of water, and besides very few suspended particles of dust or smoke: snow will not melt even on high mountains in the tropics; notwithstanding the great amount of solar heat received by the upper surface of the snow, this heat will be radiated back into space, and the air, being very diathermanous, will retain scarcely any of it. In the lowlands of higher latitudes the air is not rarefied, but in the presence of a great extent of snow the other conditions are similar to those prevailing at great heights in the tropics, especially the freedom from dust as well as the small quantity of vapour of water. The latter is due to the low temperature prevailing, the former to the absence in the vicinity of dry ground uncovered by snow from which the wind could carry away dust, as well as to the absence, or at least the small amount, of organic life. In this case, as well as on high mountains, radiation into space goes on freely, and the solar rays are unable to melt the snow so long as it retains its feathery structure, and its surface is not covered by any dark object which will be heated by the sun's rays and will melt the snow around it. Thus we see the snow thawing on roofs, around trees, &c. when a surface of snow completely free does not show the slightest traces of thawing. I have seen a piece of brown paper in a garden exert a very great influence; after some sunny days in February or March the surface of snow under that would be much lower than around. It suffices to cover snow with the thinnest layer of coal dust to see even a greater effect of the same kind.

From the above premises I arrive at the conclusion that if once a great extent of continent has been covered by snow this snow will not melt under the influence of the sun's rays. Now we know that every spring and summer the winter snow does melt in the northern parts of the continents of Europe, Asia and North America. It is fair to ask how does this come about? The records of observations in high northern latitudes show that the temperature is mostly below the freezing-point up to the beginning or middle of June, *i.e.* to a time when these latitudes receive per day a quantity of solar heat much larger than is ever received at the equator, and that continuous frost lasts in these latitudes a month to six weeks, during which the sun does not set. Besides, the solar rays are not much intercepted by clouds, May being generally a clear month in high northern latitudes. Thus, at Polaris Bay, North Greenland, lat. 81° 36′ N, the sun does not set after April 11th; and

yet in 1872, from that date till June 1st, the temperature of the air did not rise above 0° C, except for ten hours on May 21st, whilst from June 2nd the temperature was constantly above 0° C (a very few hours excepted), and yet in May, especially in the beginning of the month, as well as in April, there were frequent clear days. The United States Expedition, under Captain Hall, passed the next winter at Polaris House, Lifeboat Cove,[1] lat. 78° 23′ N, where the sun does not set from April 20th. Here also there was no general thaw till the end of the observations on May 31st, but only slight thaws on the 16th, 22nd and 27th, though there were many clear days. Thus on May 8th the sky was quite clear for some hours before and after noon, and the temperature was —14°·4 C at noon, and —15°·1 C at 3 p.m.; it was also quite clear on the 31st from 6 a.m. to 6 p.m., and the temperature did not rise above —8°·8 C. The observations of the *Vega*, at Pitlekaj, near Behring's Strait, at a much lower latitude, 67° 5′ N, showed even a later rise of temperature above freezing-point, viz. June 18th, after which date the temperature sank below freezing-point only for a few hours. Before that date the temperature rose for a few hours above 0° C on May 9th, 14th, 17th, 18th and 31st, and June 1st, and in every case with a completely overcast sky, while, *e.g.* on a clear day, May 3rd, the temperature did not rise above —13°·4 C. On June 3rd, with a clear sky till after noon, the temperature was —6°·9 C.[2] These examples clearly show that in high northern latitudes the heat of the sun's rays at the end of spring and the beginning of summer is able to raise the temperature above the freezing-point. How then does the thaw begin? I have no doubt that it is first caused by winds from warmer quarters, or from continents or open oceans. The observations of the *Vega* show that till June 12th inclusive the winds were Northerly, but changed during the afternoon on the 13th to South-south-west. These warm winds cause the upper layer of snow to melt; after it has been frozen again it is changed to *névé*, *i.e.* to a condition in which it is somewhat diathermanous to solar heat and radiates heat much less freely. Once this is done the melting of snow goes on much more easily. To a small extent the melting of the snow may be helped by dust brought by the winds from continental areas already free from snow. If the warm winds do not last long enough, or are not strong, they will not have lasting results,—the next fall of snow will re-establish a layer only slightly diathermanous and having very great radiating power. As a great quantity of heat is also expended on the melting of the snow, the warm winds will lose a great part of their heat; thus their full effect will be exerted. But near the border of the snow-covered country, when the snow has mostly melted there, the surface of the ground can be heated by the sun and thus become a source of heat for the country situated northward. Hence there is an advance, step by step, of the melting of the snow, from say February to June in the Northern Hemisphere. It begins close to

[1] The observations at both places are published in detail in the *Scientific Results of the U.S. Arctic Expedition, Steamer Polaris.* Vol. I. Washington, 1876.

[2] *Observations météorologiques faites par l'Expédition de la Vega*, réduites par Hildebrand Hildebrandsson.

seas which do not freeze and continental areas which are not covered permanently with snow even in mid-winter, and continues advancing more and more northward and inland till all the lowlands of our hemisphere are, so far as we know, freed from their snow-covering.

The process is not continuous, but proceeds, so to say, by leaps and bounds. Warm winds from the South or from the sea carry it farther on, whilst cold winds not only stop its extension, but give temperatures below 0° C to countries where the melting had already begun. The disappearance of the snow from all the lowlands of the Northern Hemisphere is caused by its geographical position, all known parts of it being reached by warm winds, which lead to the first melting of snow. Besides, in some of the countries in the highest latitudes the snowfall is very light, so that there is not much to melt. Yet this condition of things is not a necessary one; it is possible that snow may remain on the ground in the lowlands during the whole summer, and thus temperatures below freezing-point be the rule even at this season. This is not only possible, but such a condition really does exist in high southern latitudes. Near the shores of the Antarctic Continent, or the islands bound together by glacier ice and appearing like a continent, we know by the observations of the expedition of Sir James Ross that the mean temperature is much below the freezing-point even in the height of summer, and that the temperature scarcely ever rises above that point. Thus there is no notable melting of snow, and what is melted is very soon replaced by fresh snow, *e.g.* the above-mentioned observations show that out of 100 days there were

In lat.	60°—70° S.,	2 with rain	and	27 with snow.
,,	70°—75° S.,	1	,,	30	,,
,,	75°—78½° S.,	1	,,	20	,,

Here again the geographical position explains the result. The shores of the Antarctic Continent are at a distance of 20° or more from any land area of lower latitude, the latter can thus have no appreciable influence on the temperature of the former. It is influenced by the seas to the northward of it, but the observations show that the surface of the sea has a temperature below freezing-point from the shores of the Antarctic Continent to about lat. 62° S even in summer. Thus the Antarctic Continent cannot receive from any quarter the warm winds which could initiate the melting of the snow; and, as the snow covering remains the whole summer, we see that the sun's rays are unable to raise the temperature above freezing-point, notwithstanding the nearness of the sun to the earth in the summer of the Southern Hemisphere.

From this example of the existence of a covering of snow lasting the whole year I return to the Northern Hemisphere. There is a very important effect of an extensive covering of snow which deserves more attention than has been paid to it till now, viz. the possibility of temperatures but slightly exceeding the freezing-point.

TABLE I.

Place.	Month.	Mean.	Mean Min.	Mean Max.	Absolute Max.	Place.	Month.	Mean.	Mean Min.	Mean Max.	Absolute Max.
		°	°	°	°			°	°	°	°
Bogoslowsk ...	Feb.	−17·0	−41·2	−2·6	0·6	Barnaul	Feb.	−17·0	−38·2	−0·4	5·0
	Dec.	−18·3	−40·2	−1·5	3·0		Dec.	−15·5	−38·1	0·2	5·1
Ustissolsk......	Jan.	−15·2	−32·9	−1·9	3·8	Irgiss ...	Jan.	−15·9	−30·5	−0·3	2·7
	Feb.	−12·8	−30·3	−0·4	6·2		Feb.	−16·3	−32·5	−0·8	2·4
	Dec.	−13·8	−32·2	−0·6	3·1		Dec.	−11·7	−28·6	2·5	9·6
Kasan	Dec.	−12·0	−28·3	1·9	4·7						
St. Petersburg	Jan.	− 9·4	−25·0	1·2	5·6	Sarepta ...	Jan.	− 9·7	−25·9	2·5	5·0
	Feb.	− 8·6	−24·0	2·2	6·0		Feb.	− 9·0	−23·2	4·2	10·6
	Dec.	− 6·6	−21·3	2·4	7·5		Dec.	− 6·2	−21·8	5·2	9·4
Kursk	Jan.	−10·2	−25·9	1·4	5·6	Lugan ...	Jan.	− 8·3	−25·0	4·5	8·6
	Feb.	− 9·1	−23·2	2·2	6·8		Feb.	− 7·4	−23·0	4·7	13·5
	Dec.	− 6·9	−21·8	2·8	9·4		Dec.	− 5·3	−20·1	6·2	13·5
Kiew	Jan.	− 6·1	−19·1	3·6	6·4	Astrachan	Jan.	− 7·1	−22·7	3·9	9·1
	Feb.	− 5·3	−20·4	4·0	10·1		Feb.	− 6·3	−21·6	5·2	12·2
	Dec.	− 4·3	−17·1	5·2	10·9		Dec.	− 3·5	−18·2	6·9	11·9
Mitau............	Jan.	− 5·0	−17·4	3·4	7·8	Nukuss ...	Jan.	− 7·0	−23·1	7·6	11·0
	Feb.	− 4·4	−17·5	4·2	8·1		Feb.	− 3·7	−18·6	14·4	19·8
	Dec.	− 2·7	−15·5	5·3	8·2		Dec.	− 2·3	−16·2	12·5	18·6

In the foregoing table I have placed opposite one another places with nearly the same winter temperatures, those on the left side having a more regular and deeper covering of snow than those on the right.

In February the mean temperature is the same at Bogoslowsk, on the east foot of the Ural, and at Barnaul, on the upper Obi, at the foot of the Altai; but at not very great distance south-west from the latter, in the Kirghiz Steppes, there is sometimes but little snow. On this account the mean and even more the extreme maximum of February is higher. The same kind of difference obtains between Ustsissolsk (government of Wologda) and Irgiss, in the Kirghiz Steppes. In the first place, the absolute maximum of February is higher, because, 1st, the time of observation is longer; 2nd, the observations were made in the first half of this century, when the thermometers were not sufficiently protected against reflected heat, &c. The other places right and left show the same kind of difference; *i.e.* where the snow covering is less regular the mean and extreme maxima are higher, and the difference increases towards the south. It is especially great between Mitau, near the Baltic, and Nukuss, on the lower Amu Daria (Oxus). In February the mean temperature differs but by 0°·7 C, the mean minimum at Nukuss is 1°·1 lower, but the mean maximum is 10°·2 higher, the absolute maximum 11°·7, and the latter result is the more worthy of notice, since it is deduced from but six years' observations, while those of Mitau extended over more than forty years. In December the result is analogous, the monthly mean and mean minima differ very little, but the mean maxima of Nukuss are higher by more than 7°, and the absolute maxima by more than 10°. Snow seldom falls at Nukuss, a snow covering lasting only a few days is even of rare occurrence, and in the absence of snow there is nothing to check the influence of warm winds, and the sun under this latitude is able to heat the ground to a sensible degree even in mid-winter.

The influence of a snow covering on the maxima must be very different according as to whether the temperature is below or above freezing-point; in the latter case the melting of the snow, absorbing heat, will tend to check the further increase of temperature.

The melting of snow does not only prevent high maxima, but for a long time after it has begun keeps the temperature near the freezing-point. This is the reason why April is so much colder than October in central European Russia, in Canada, the north of the United States, &c. Further north the same cause operates in lowering the mean temperature of May in comparison with September. There is no doubt but this cause of cold, or rather to say, this conversion of heat into the work of melting the snow, is proportional, *cæteris paribus*, to the mass of snow remaining on the ground. Thus, in countries which have a cold winter, the chief impediment to the rise of temperature in spring will be the quantity of snow lying, and not the coldness of the winter. It is only in countries which are near to seas, or to extensive lakes on which much ice is formed, that the mean temperature of winter has a great influence in lowering the temperature of the succeeding spring, or even summer, as in cold winters more ice is formed and hence more heat must be expended on its melting than in average seasons. Countries far removed from seas and lakes are influenced in this respect only by the snowfall. The following examples will explain the *modus operandi* of these causes. In 1847-48 the snowfall over a great part of Russia was very light, in 1866-67 exceedingly heavy. The high water of the Volga at Astrachan, which is the result of the melting of snow on the whole extent of the river basin, was the lowest on record in 1848, with the exception of the year 1840, and the highest in 1867, in a period of forty years. The following table shows the difference of the temperature of the winter and spring months of these years from long averages:—

TABLE II.—Differences from the Average Temperatures.

Station.	1847—8.					1866—7.					
	Dec.	Jan.	Feb.	March.	April.	Dec.	Jan.	Feb.	March.	April.	May.
	°	°	°	°	°	°	°	°	°	°	°
Warsaw	—0·5	— 8·5	3·0	4·2	4·1[1]	1·5	1·6	4·1	—2·6	—0·8	—2·5
Mitau	—1·0	— 7·9	2·7	3·8	3·9[1]	0·9	—1·4	1·9	—3·9	—1·2	—4·4[2]
St. Petersburg	3·0	— 3·7	5·0	4·9	3·8	0·2	—3·4	2·0	—4·4	—2·7	—6·6[2]
Archangel	6·0	— 2·0	6·7	2·8	1·6	—3·5	—6·2	1·0	—4·0	—0·6	—6·3[2]
Kostroma	...	...	...	...	...	0·6	—2·4	1·1	—4·1	—0·8	—4·8
Balachna	—0·6	— 8·0	5·4	2·3	6·5	1·4	—0·6	—1·1	—4·8	0·2	—3·3
Moscow	0·0	— 7·2	5·0	2·5	7·3[1]	2·4	2·0	1·4	—5·1	—1·4	—4·0
Kursk	—2·9	— 8·4	4·5	3·3	7·1[1]	1·5	5·4	1·0	—5·2	0·3	—1·5
Kischinew	—2·4	— 6·6	2·3	1·8	4·7[1]	0·6	3·8	3·4	2·3	2·0	1.0
Nikolaiew	—4·3	— 6·3	3·0	2·0	3·8[1]	0·3	6·7	3·6	—3·3	1·5	0·6
Lugan	—5·1	— 9·4	5·0	3·5	5·9[1]	0·0	6·2	—0·3	—5·6	1·3	—1·0
Saratow	—5·1	—10·4	—1·7	1·7	6·6	...	...	...	...	...	...
Samara	...	...	...	...	...	1·7	0·5	1·5	—4·0	—1·5	—2·6
Orenburg	—4·8	— 5·9	0·6	0·6	5·0	3·6	0·9	—0·9	—2·0	—0·2	—2·4
Kasan	—1·6	— 8·1	2·2	3·4	5·3[3]	3·6	1·1	1·5	—2·5	0·9	—3·0

1 The warmest April observed in more than fifty years.
2 " coldest May " " "
3 " warmest April " with the exception of 1818.

It will be seen by the foregoing table that the winter 1847-8 was considerably colder than 1866-7, the extreme north excepted. In February of both years the temperature was above the average. March 1848 was warm, while March 1867 was cold. On account of the light snowfall of winter, and the high temperature of March 1848, there was scarcely any snow lying in the vicinity of Moscow in the beginning of April, and already on the 12th the temperature rose to 24,° a temperature which in ordinary years is not common even a month later. April 1848 was the warmest of long periods of observation over a great extent of territory, in the west to beyond the Russian frontier, in the east to about Kasan, and in the south to the Black Sea and Sea of Azof.

The snowfall of 1866-67 was exceedingly large over a very great extent of Russia, as was proved by the large and long continued high water, not only of the rivers belonging to the Volga basin, but also to that of the Neva. That of the Wolkow was especially noticed, and the Ilmen lake flooded its shores over a great extent. The great amount of snow as well as of ice on the lakes and seas was the cause of the exceedingly low temperature of May, the lowest on record in the North of Russia during the whole period of observation (in St. Petersburg over 140 years). I am ready to meet an objection which might be made against my conclusion that there is a greater probability that the sign of the difference will remain the same as in the foregoing month; this is true, but the difference of the probabilities either way is not great. Both of the years here mentioned showed changes of sign of a very thorough character, 1848, from January to February; 1867, from January to February, and February to March. The following examples show how great the change of sign can be in Russia in the spring months:—

TABLE III.

Month.	St. Petersburg.						Orenburg.	
	1770.		1839.		1871.		1860.	
	Mean.	Difference from Average.	Mean.	Difference from Average.	Mean.	Difference from Average.	Mean.	Difference from Average.
	°	°	°	°	°	°	°	°
February	—7·8	0·8	—9·4	—0·8	—19·5[1]	—10·9	—16·1	—1·5
March	—10·4	—5·7	—10·0	—5·3	—0·4	4·3	—17·4[2]	—8·4
April	6·6[3]	4·6	—2·3	—4·3	0·5	—1·5	4·9	1·7
May	9·5	0·8	13·4[4]	4·7	5·5	—3·2	14·6	0·6

[1] Coldest February in the whole period.
[2] Coldest March ,, ,,
[3] Warmest April ,, ,,
[4] Warmest May ,, ,,

The foregoing conclusions can be also expressed thus: at the period when the mean temperature begins to rise above the freezing-point, very much depends on the store of cold existing in the vicinity in the form of snow and ice. The larger it is, the slower and more irregular will be the rise of temperature.

The time when a covering of snow appears, its depth and extent have also a great influence on the beginning of winter frosts and their duration, not only where the snow already lies, but also to the southward (in the Northern Hemisphere). I may express it thus:—Snow gives a permanency to cold and prevents a rapid increase of temperature. If we knew exactly the time when a covering of snow was formed to the northward (or landward) of us in autumn and winter, and that was communicated by telegraph, much could be done towards forecasting the time of freezing of rivers and canals, and thus information might be gained, which would be very important for the interests of very large tracts of our globe, *e.g.* the greater part of Asiatic and European Russia, Scandinavia, British America, and the Northern United States. A forecast of the closing of rivers and canals by ice, even limited to four or five days, would be of enormous benefit to the large shipping interests of these countries. A great loss would be prevented in years of early frosts, whilst when the season is late, navigation might go on without fear. Two recent winters in Central Europe show very clearly the influence of a covering of snow in producing low temperatures. In 1879-80, as well as in 1881-2, there were long-continued anticyclones over Central Europe, with clear skies, *i.e.* conditions very favourable to low temperatures, yet the temperature was much higher in January 1882, on account of the absence of snow, than in December 1879, when an anticyclone followed a severe snowstorm, after which a thick layer of snow covered nearly all Central Europe. The mean temperatures of five-day periods at Zürich, during which the centres of anticyclones were near the Alps, were as follows:—

		C.			C.
1879, Dec.	7—11	−18°·0	1880, Jan.	16—20	−6°·1
„	12—16	− 9°·6	„	21—25	−9°·5
„	17—21	−10°·5	1881, Dec.	27—31	−4°·2
„	22—26	−10°·5	1882, Jan.	11—15	−1°·4
1880, Jan.	6—10	− 8°·5	„	16—20	−8°·2
„	11—15	− 4°·0	„	21—25	−8°·5

According to Dr. Billwiller[1] the snow lasted till the end of December 1879, but then it melted; and when Central Europe was again under the influence of an extended anticyclone, in January 1880, the mean temperature was much higher. In the middle of January snow fell again, and the mean temperature was about as low at the end of January as in the end of December 1879. In 1881-82 there was no snow on the ground, and, notwithstanding the extensive and long-continued anticyclones, the minimum temperature fell but to —8°·5 at Zürich on December 26th, 1881, and was even higher in January; while it had been below —20° in December 1879 at Zürich as well as in other valleys in Switzerland.

In all countries where snow accumulates to a considerable depth in winter, the rivers have regular high water in spring or the beginning of summer,[2]

[1] *Zeitschrift für Meteorologie.* Vol. XVII. p. 98.

[2] See my paper "*Les Rivières et les Lacs de la Russie,*" *Arch. des Sciences Phys. et Nat.* (Geneva.) Jan. 1885.

the result of the melting of snow. The quantity of water set free by the melting of snow and ice is so great that the melting takes place on large spaces at once, and the evaporation being so small, that in these countries the larger rivers have never a high water due to rains at all to be compared to those due to the melting of snow. This latter is thus very important for many matters of practical life, yet, strange to say, the mode of melting of the snow has not received the necessary degree of attention. The results of the melting will be much influenced by its rapidity, as well as by the quantity of snow lying on the ground at the end of the frost. If it melts very rapidly inundations may result, and the duration of high water will be so short as to be of very little use to navigation; the reverse will be the case when the melting is slow and gradual.

A popular saying in Russia is to the effect that when there is little snow the water will be high, when there is much snow the water will not be high. This is certainly paradoxical, but not without some truth for small rivers. When there is little snow in winter the ground is frozen to a considerable depth, and when the first water arrives at the surface of the soil it is frozen again and a crust of ice is formed, over which the water flows as it would over rock or clay, without penetrating it. It thus speedily reaches the rivers, and causes a rapid rise of their waters.

When there is much snow it protects the soil, and to such an extent that the melting may begin from below, so that no ice-crust can be formed on the surface of the soil and the melting water penetrates into it and only reaches the ravines and rivers after some time, *i.e.* after it has saturated the soil. The Russian peasants call this "earth water" (Zemlianaya woda), and observation shows that it flows oftener from forests than from fields, the reason being that in forests the snow accumulates to a greater depth and is not disturbed by winds, which often blow away a great part of the snow from higher open ground.

In 1884 the melting of the snow from below was observed at the Agricultural Academy of Petrowsky, near Moscow. The observations on the temperature of the soil were as follows:—Observations were made at the surface and also at depths varying from 25, 50, &c. centimetres to 2 metres inclusive. At 75 centimetres the temperature first reached the freezing-point on March 5th, and the daily mean was —0°·5 from the 16th to 18th. The daily means are given in Table IV. (p. 308.)

It will be seen that the temperature rose earlier above freezing-point at the depth of 75 centimetres than at 50 and 25. As similar conditions prevailed in many parts of the Volga basin, the high water of the river in 1884 was not above the average, notwithstanding the depth of snow, but the springs were so well supplied with water by the gradual melting of the snow, that navigation was not impeded during the whole summer and autumn. It was the reverse in 1880, when a colder winter with less snow was favourable to rapid melting of the snow; the high water was one of the greatest on record, but soon fell off, and from August to October navigation was much impeded by low water every where above the mouth of the Kama.

TABLE IV.

1884.	Depth. Surface.	25 Centimetres.	50 Centimetres.	75 Centimetres.	1 Metre.	1884.	Depth. Surface.	25 Centimetres.	50 Centimetres.	75 Centimetres.	1 Metre.
	°	°	°	°	°		°	°	°	°	°
March 25	—2·6	—0·8	—0·5	—0·1	0·6	April 2	—4·7	—0·4	—0·3	0·2	0·7
„ 26	—7·2	—0·7	—0·5	0·0	0·6	„ 3	—1·3	—0·4	—0·3	0·2	0·7
„ 27	—2·4	—0·9	—0·4	0·0	0·7	„ 4	0·5	—0·3	—0·2	0·2	0·7
„ 28	—0·3	—0·9	—0·4	0·1	0·7	„ 5	0·1	—0·3	—0·2	0·2	0·7
„ 29	—0·7	—0·8	—0·4	0·1	0·7	„ 6	0·8	—0·3	—0·1	0·2	0·8
„ 30	—0·6	—0·8	—0·4	0·1	0·7	„ 7	—1·8	—0·2	—0·1	0·3	0·8
„ 31	—4·7	—0·6	—0·4	0·1	0·7	„ 8	—1·4	—0·2	—0·1	0·3	0·8
April 1	—6·3	—0·4	—0·3	0·1	0·7	„ 9	—1·1	—0·1	0·0	0·3	0·9

All that pertains to the covering of snow on the ground is of so great importance for science as well as for practical life that it ought to be observed and published in detail. It would be necessary to know when the snow first covered the ground, its structure at different times of the cold season, its depths in different places, *e.g.* forests or parks, fields, ravines, &c., the time when it began to melt, and the progress of the melting as well as the condition of the upper layer of the soil under the snow, *i.e.* if a crust of ice was formed or not, and where, &c., some particulars about high waters in rivers would also be desirable. The observers of these phenomena might be those who make meteorological and phenological observations in the country. The only point which might be considered difficult is the observation of the depth of snow in different conditions. It would be best to have posts prepared beforehand, painted white with clear horizontal divisions in black or red, so as to be easily observed from a distance. The best idea of the average depth of snow can be gained in forests, gardens, or parks, where the snow is protected from drifting by the trees. In open situations a greater number of observations are necessary on account of the variability of the depth of snow, which will be frequently blown away from high or low level ground and accumulated in ravines or against any obstacle, such as a building, fence, &c. Yet I think that an intelligent observer with proper directions will soon learn how to observe, and will find a great interest in such observations. After they have been systematically continued some time, and general deductions made from them, it will be possible for central meteorological institutions to receive telegrams of the state of the snow along with other meteorological telegrams, and draw important practical conclusions, especially as to (1.) the probable time the rivers will remain open, so that navigation can go on without interruption; (2.) the probable state of the water in rivers after the melting of the snow; and (3.) the probable character of the spring, a great quantity of snow being favourable to a late spring, other conditions being equal.

As to the last point, I have the experience of successful predictions by

Mr. Blanford as to the character of the following season in Northern India, according to the extent and depth of snowfall in the Himalaya.

I venture to draw the attention of the Royal Meteorological Society to this subject, though I know very well that on account of the mild winters of the British Isles it has less interest and importance for them than for some other countries. But the British Empire extends to many lands, and among them British North America has, next to Russia, European and Asiatic, the greatest extent of winter snow; and close to it is another English speaking country, the United States, for the northern part of which the subject has also the greatest interest.

I was led to consider the subject as far back as 1871, and published a short paper on it in the *Isvestia* of the Imperial Russian Geographical Society of that year. It was translated into French, and published in the *Nouvelles Météorologiques* 1871. The fourteen years which have passed since that time have been very fruitful for meteorology, both in its theoretical aspect and in the extension of observations, and also the better use made of them for the benefit of mankind. I hope that the appeal I now make will not be in vain.

DISCUSSION.

Prof. ARCHIBALD said this same subject had been studied by Mr. Blanford, who had found in India that a heavy snowfall on the Himalaya was almost invariably accompanied by drought on the plains.

He thought it very possible that a heavy snowfall on the Scandinavian Peninsula might similarly affect the British Isles; while he had already drawn attention in *Nature* to the probability that the movements of the ice near Iceland affected our area in the summer. With regard to the question whether the snowfall in the Himalayas was really the cause of the drought, as advocated by Mr. Blanford, he preferred for the present to regard them both as due to some common cause as yet unknown.

Mr. WHIPPLE said that the accurate determination of the ratio a given measurement of snowfall bore to an equivalent fall of rain was very important, and he urged that some one should thoroughly investigate the subject in order to settle the question.

The PRESIDENT (Mr. Scott) said that the measurement of snow was apparently not a difficult matter, but that it was found impossible to say whether the snow caught in a gauge fell into it from the clouds or was drifted into it by the wind: he cited particularly the snow storm of January 18th, 1881, which had occurred with a terrific gale of wind, and where large areas perfectly bare lay close to deep drifts.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE IN THE SOLOMON GROUP, 1882-1884. By LIEUT. ALEXANDER LEEPER, R.N., F.R.Met.Soc.

[Read June 17th, 1885.]

THE Solomon Islands, lying as they do between the South-east Trade Wind and the North-west Monsoon, and also being in the vicinity of such large tracts of land as Australia and New Guinea, are subject to variable winds, violent squalls, and a very heavy rainfall. The North-west Monsoon extends over the whole group from about the end of November to the end of March, and is considered the rainy season.

Heavy gales from North-west and West also are not infrequent at this period.

The South-east Trade Wind nominally lasts from April to the beginning of November, blowing for the most part from East and East-south-east (magnetic), but as a rule it does not blow home, as in Fiji and the groups to the Eastward. It seems to blow in fits and starts, interrupted with calms, variable winds, and often heavy squalls and much rain. The group extends from lat. 7° to 10° S, the temperature consequently varies but little all the year round, the range being from 75° at night to from 90° to 95° at noon.

The barometer range is from 29·83 ins. to 30·18 ins.

The temperature of the sea varies from 82° to 85°.

The accompanying synopsis was prepared from a meteorological log kept during the stay of H.M. Surveying Schooner *Lark* in the group, from April to November, in the years 1882, 1883 and 1884. The instruments were supplied by the Marine Department of the Meteorological Office, and had been previously verified at the Kew Observatory.

The mercurial barometer was suspended in the chart room between decks, its cistern being about at sea-level. The outer air had free access to the thermometers, which were placed in the coaming of the after hatchway; they were protected by wooden jalousies from sun and spray.

The directions of wind are magnetic, the variation of the compass being 7° to 8° East.

REMARKS.

1882.

APRIL.—The first part of the month had calms and light Northerly winds with showery weather; the latter part calm, and light South-east winds with fine weather. Thunderstorms frequent.
1st to 5th, off Cape Surville. 6th to 14th, at Port Mary, Santa Anna Island. 14th to 18th, at Ugi Island. 21st to 27th, at Niboli Harbour, Florida Island. 28th to 30th, proceeding to Simbo Island.

MAY.—Numerous calms and light winds from North-west through South to South-east. Thunderstorms frequent.
1st to 6th, proceeding to Simbo (Narovo) Island. 7th to 15th, at Simbo Island. 16th to 24th, off Treasury and Simbo Islands.
24th to 31st, proceeding to Ugi Island.

JUNE.—Calms, North-north-east and Easterly winds; average force of wind 2.
1st to 7th, proceeding from Simbo to Ugi Island.
11th to 18th, „ „ Ugi to Santa Anna Island.
19th to 30th, at Bunny Anchorage, San Christoval Island.

JULY.—Very hazy over the land; South-easterly winds with frequent heavy squalls first part of month. Latter part light South-east winds, with one week's South-westerly wind with fine clear weather.
1st to 5th, at Bunny Anchorage. 6th to 16th, at Ugi Island.
Remainder of month along North-east coast of San Christoval Island.

AUGUST.—Wind between South and East-north-east; average force 3-4.
Frequent rain squalls and haze over the land.
At Ugi Island and along North Coast of San Christoval Island during the month.

SEPTEMBER.—During the latter part of the month experienced heavy South-east winds, thick weather and violent squalls.
At Ugi and Sisters' Islands.

OCTOBER.—South-easterly winds with much rain; towards the latter end of month Easterly winds and calms prevailed.
At Ugi, Rua Sura and Santa Anna Islands.

REMARKS—*Continued.*

1882.

NOVEMBER.—Very calm weather, experienced great difficulty in getting from place to place.
At Ugi and Santa Anna Islands till 21st. Left group on 22nd.

1883.

APRIL.—Arrived in group on 14th, at Santa Anna Island and Ugi Island during month.
Winds Northerly and North-west, with a good deal of rain 14th to 22nd and heavy squalls.
23rd to 30th calms, and light Easterly winds with several passing showers.

MAY.—No observations; proceeding to Brisbane with a shipwrecked crew.

JUNE.—The early part of the month was very fine with light East and South-east winds; the last ten days were very squally, thunderstorms and much rain.
2nd to 18th, at Blanche Harbour, Treasury Island.
19th to 22nd cruising off Blanche Harbour, Treasury Island.
23rd to 30th, at Alu Island, Bougainville Straits.

JULY.—Light variable winds from North-west to South-east. Frequent showers of rain. Few squalls.
At Treasury Island and cruising in Bougainville Straits.

AUGUST.—General direction of wind East-north-east to South-east. Force 2 to 3. Occasionally misty. Few squalls.
1st to 6th, at Ballalé Island. 7th to 10th, cruising.
11th to 13th, at Tagarei Island. 14th to 31st, at Toma.
All being in Bougainville Straits.

SEPTEMBER.—Calm weather and on the whole fine, no heavy squalls.
At Treasury Island and in Bougainville Straits.

OCTOBER.—Several heavy squalls with thunder and lightning; Trade Wind very Southerly.
1st to 3rd, at Choiseul Bay. 4th to 9th, at Piedu Island, Bougainville Straits.
20th to 23rd, cruising.
24th to 31st, at Blanche Harbour, Treasury Island.

NOVEMBER.—2nd to 12th, working to Eastward from Treasury Island.

1884.

APRIL.—Arrived in group on 5th, at Treasury Island 10th to 18th. At Alu Island remainder of month.
9th to 11th, light Westerly winds with heavy rain, 4·3 inches were registered on 11th.
Light Northerly and Westerly winds and calms the remainder of the month, with fine, clear, dry weather.

MAY.—Light North-east and Easterly winds, with a great deal of calm weather.
At Alu 1st to 13th, Bougainville Straits 14th to 23rd.
Treasury Island 24th to 31st.

JUNE.—The first half the month light East and East-south-east winds. The last half, light South-east and South-south-east. Weather on the whole fine, though inclined to be squally. An occasional light North or North-east wind.
In Blanche Harbour 1st to 4th, Bougainville Straits 5th to 19th.
North Bay, Faro Island, the remainder of month.

JULY.—1st to 14th, light South-easterly winds and calms with fine clear weather.
15th to 27th, fresh Easterly winds, cloudy weather, with a good deal of rain.
Remainder of month, fresh Southerly winds, with bad weather.
At North Bay, Faro Island, 1st to 9th. Treasury Island 11th to 28th.

AUGUST.—The first half of the month had steady Southerly winds, rather fresh, with thick weather, and numerous rain squalls. The second half, the wind was lighter and more variable with occasional calm spells. Wind chiefly from South-east.
At Oema Atoll, Bougainville Straits, till 21st; cruising in Straits, 21st to 26th; then at Alu Island.

Month.	Temperature.							Barometer.							Rain.		Temperature of Sea. Mean at Noon.
	Highest.	Lowest.	Mean 4 a.m.	Mean 8 a.m.	Mean 4 p.m.	Mean 8 p.m.	Daily Mean.	Highest.	Lowest.	Mean 4 a.m.	Mean 8 a.m.	Mean 4 p.m.	Mean 8 p.m.	Daily Mean.	No. of Days.	Amount.	
1882.	°	°	°	°	°	°	°	In.	In.	In.	In.	In.	In.	In.		In.	°
April	94	74	81·8	86·5	86·9	82·5	84·4	30·09	29·88	29·996	30·007	29·954	30·206	30·041	18	...	85·3
May	94	78	80·5	86·4	86·4	84·8	84·5	30·09	29·89	29·981	30·018	29·954	30·024	29·994	21	...	84·8
June	92	77	80·7	85·8	86·5	81·8	83·7	30·18	29·86	30·015	30·052	29·979	30·007	30·013	15	...	84·9
July	90	75	79·0	83·3	85·1	79·7	81·8	30·14	29·92	30·04	30·06	30·01	30·08	30·05	22	...	83·6
August	94	75	78·9	79·4	85·2	80·9	81·1	30·16	29·96	30·06	30·10	30·03	30·087	30·067	16	...	82·5
September	92	76	77·9	79·7	83·3	82·8	80·9	30·14	29·93	30·026	30·08	30·00	30·06	30·041	21	From the 8th 18·4	81·8
October	89	77	78·9	80·6	84·2	82·1	81·4	30·18	29·88	29·988	30·07	29·97	30·054	30·021	27	10·57	82·3
Nov. 1st to 22nd	88	78	78·8	81·2	84·0	82·0	81·5	30·13	29·84	29·97	30·00	29·95	30·006	29·981	15	18·43	83·3
1883.																	
April 14th to 30th	92	75	79·0	80·1	86·6	82·8	82·1	30·08	29·86	29·96	30·01	29·928	29·998	29·974	14	...	83·4
May	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
June	93	78	79·3	81·4	84·7	81·9	81·8	30·08	29·91	29·969	30·021	29·95	30·00	29·99	26	16·32	83·8
July	94	75	79·2	81·0	86·3	82·7	82·3	30·12	29·88	29·899	30·017	29·937	29·993	29·96	24	10·25	83·1
August	92	78	80·6	81·8	88·0	83·9	83·5	30·08	29·92	29·98	30·028	29·95	30·01	29·992	28	7·85	83·0
September	95	76	79·5	81·2	87·0	82·9	82·6	30·10	29·91	29·95	30·04	29·958	30·02	29·992	26	15·19	83·0
October	95	75	81·1	81·5	86·7	84·1	83·3	30·12	29·86	29·883	30·036	29·944	30·011	29·993	26	11·11	83·0
Nov. 1st to 12th	90	76	79·2	81·2	84·0	81·6	81·5	30·08	29·91	29·954	30·03	29·946	30·00	29·982	7	...	82·3
1884.																	
April 5th to 30th	90	76	79·9	81·4	85·3	82·4	82·2	30·15	29·83	29·97	30·048	29·91	30·01	29·984	14	8·87	84·0
May	95	78	81·0	83·2	88·2	83·7	84·5	30·13	29·86	29·976	30·015	29·965	30·014	29·992	17	4·02	84·5
June	94	77	79·4	81·3	86·0	82·0	82·2	30·14	29·93	30·008	30·055	29·996	30·032	30·023	22	9·23	84·0
July	87	76	79·7	80·5	84·0	82·0	81·5	30·10	29·87	29·966	30·025	29·955	29·993	29·985	24	18·27	83·0
August	87	76	79·0	80·2	84·0	80·8	81·0	30·15	29·85	29·99	30·046	29·981	30·02	30·009	24	11·94	82·0
September	90	75	78·3	80·3	84·2	81·1	82·3	30·15	29·92	30·006	30·067	29·987	30·039	30·025	23	17·46	82·3
October	96	75	79·1	80·9	85·6	78·9	81·1	30·12	29·85	29·967	30·054	29·98	30·027	30·007	23	10·95	83·0

REMARKS—*Continued.*

1884

SEPTEMBER.—1st to 13th, light South-east and Easterly winds, with occasional squalls, with heavy rain from North-east and East-north-east. 14th to 20th, very fresh Southerly winds and thick dirty weather; remainder of month light Easterly winds and fine weather.
At West side, Alu Island (Bougainville Straits), till 15th.
At Treasury Island the remainder of month.

OCTOBER.—From 1st to 7th, light winds from North-east to South-east, with a good deal of rain; 8th to 15th, Southerly winds, force 2—4. Showery.
16th to 22nd, Northerly winds, force 3—8. o, q, r, t, l. Remainder of month fine, with light variable and East-south-east winds.
1st to 13th, at West side, Alu Island; 14th to 21st, Choiseul Bay; then at Treasury Island to 27th; when left group.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

MAY 20TH, 1885.

Ordinary Meeting.

ROBERT H. SCOTT, M.A., F.R.S., President, in the Chair.

HORACE DOBELL, M.D., Streate Place, Bournemouth; and
JOHN NEEDHAM LONGDEN, 1 Queen Victoria Street, E.C.,
were balloted for and duly elected Fellows of the Society.

The following Papers were read, viz.:—

"THE TEMPERATURE ZONES OF THE EARTH CONSIDERED IN RELATION TO THE DURATION OF THE HOT, TEMPERATE, AND COLD PERIODS, AND TO THE EFFECT OF TEMPERATURE UPON THE ORGANIC WORLD." By DR. W. KÖPPEN, Hon. Mem.R.Met.Soc. (p. 255.)

"VELOCITIES OF WINDS AND THEIR MEASUREMENT." By Lieut.-Col. H. S. KNIGHT, F.R.A.S., F.R.Met.Soc. (Abstract.)

MANY circumstances point to the advantage of having the means of ascertaining with accuracy the velocity as well as the direction of the wind—not only is the temperature of the air affected by the direction from which the wind blows, but also by its velocity and the length of time it continues from the same quarter.

With regard to anemometers, it seems generally admitted that the best form for ascertaining the velocity of the wind is that invented by the late Dr. Robinson, of Armagh, as it possesses the advantage of not having its action in the least affected by sudden shifts in the direction of the wind. It may be briefly described as follows:—Four hollow hemispheres are attached by four horizontal arms of equal length to the top of a vertical spindle, which acts by an endless screw on a graduated disc or discs. It has been computed that the wind causes these hemispheres or cups to move with one-third of its velocity, and this assumed rate is adopted in graduating the discs, in order that they may denote the true velocity of the wind. But this relative rate between the wind and cups deserves further consideration, as it does not seem strictly correct for all velocities. The positions of the cups are the following:—The arms are at right angles, and the cups have their concave surfaces turned towards the convex side of the next following cup; thus, while the cup on the West side has its concavity North, the cup on the corresponding arm towards the East has its similar side towards the South. Suppose the wind blowing from the North, and the cups numbered as follows:—No. 1 West, No. 2 South, No. 3 East, and No. 4 North; then No. 1 on the West side receives the wind in its concavity, and there being no escape the wind exerts its

full force, while cup No. 3 on the opposite arm towards the East presenting its convex surface, the wind glances off, exerting but little pressure. Thus the difference of wind force on cups Nos. 1 and 2 causes the former to move with the wind, and the latter against it; thus each cup in turn arrives at the place of No. 1. But it is clear that when the wind strikes the convex surface of cup No. 3 its form tends to throw the air current outwards, and the air filling its concavity must move in a direction contrary to the wind, viz. from South to North, and in this advance it must in a measure be retarded by the wind from the North; the result must be a rarefaction of the air at its concave side, and this must increase in a corresponding ratio with its velocity. Now the weight of the atmosphere may be considered equal to fifteen pounds to the square inch at sea-level, and from whatever cause the air becomes rarefied at one surface it will exert a pressure on the other surface equal to such rarefaction until, in case of a vacuum, it would amount to fifteen pounds. Thus it appears that cup No. 3, on the East side, has to sustain a pressure on its convex side from the weight of the atmosphere in consequence of the rarefaction of the air at its concave side (a pressure which increases with its velocity), in addition to the retarding force of the wind. Further, the great pressure at the same moment on the cups East and West must cause increased friction by bearing the spindle towards the south side of its tube. In order to correct these causes of error the author suggests the following alteration, viz.:—From the centre of each cup cut out a circular portion according to the size of the cup; thus in a cup measuring six and a half inches over its convex side, remove three inches and close this opening by a shutter of similar form to the removed segment; secure this at its upper edge by a good hinge so that it may swing freely towards the concave side. The edge of the shutter should project beyond the extent of this centre aperture and its edges be counter-sunk when closed, so that it may fit perfectly close and airtight when in that position. The circular form is better than a flat shutter, but both its form and size may be open to improvement.

Let us now consider the anemometer at work with its altered cups, the wind North as before, No. 1 cup West, and No. 3 East; then the shutter of No. 1 cup being closed by its weight and force of the wind would act as before, but No. 3 cup on the East side would have its shutter opened by the wind, which, passing through the opening, would relieve it from much retarding pressure and friction. When arriving at the North side, the shutter, being relieved from wind pressure, would swing down on its hinge and close the opening: should this action not be quick enough in consequence of its want of weight, the author suggests that a metal peg should be fixed to its centre on the concave side and perpendicular to it; but this may not be found necessary. The arm supporting the cup should be so formed as not to interfere with the motion of the shutter. The hinge of the shutter should not be placed at the top of the opening in a horizontal position above its centre, because the centrifugal force caused by the rotation of the cups would in such a position cause it to press too much on its outer side; but it should be placed about 20° from this point on the inner side and inclined to this extent from the horizontal. Thus the hinge would have an inclination towards the spindle of about 30°, the outer part inclining equally upwards. The hinge should have a long bearing, not less than one-third of its diameter and both the shutter and opening should be straight at the hinge.

As the wind moves with greater velocity in proportion to its altitude above the surface of the ground, the author considers that the best method for ascertaining these rates of motion is by timing the velocities of bodies floating in the air at known heights while passing over measured distances. To carry out this idea he suggests the use of small balloons filled with hydrogen gas. These balloons could be adjusted to the exact buoyancy of the air at the time and place of using them by attaching a small bag containing dry sand or water, and an arrangement could be made to allow of a small escape of a portion of this counterpoise to ensure the balloon keeping the same level. The balloon could be captured at the end of the measured distance by a light wire grapnel attached to it by a piece of string—which would catch in a cord stretched over the ground at a suitable height. The place selected for these experiments should be level and free from trees or buildings—but it would be of advantage to use these balloons over water as well as over land, also at different heights with the current moving in the direction of the wind as well as against it, which would show the resistance offered

to the wind by the water. The balloons could be started from a net of semi circular form and attached to a hoop, which by being turned on a pivot the balloon would be ejected by the wind—or by being placed in a case open towards the wind, with two doors opening on the reverse side.

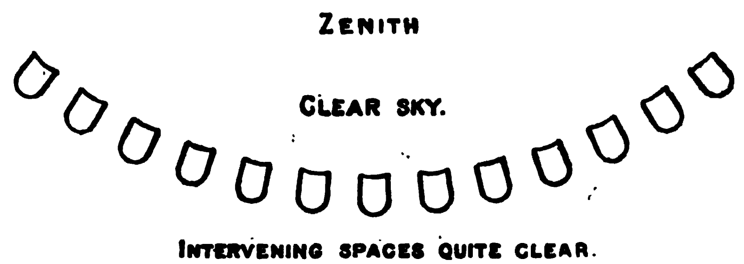
In testing anemometers with these balloons it would be an advantage to adopt an arrangement by which they could be started and stopped at the instants at which the latter arrived at and completed the measured distance.

The author mentions a few essential points required in the construction of anemometers which, not being of a decorative character, receive but little attention from opticians. The pivots of the parts in motion should be placed well in view and readily accessible, so that oil may be easily applied to them without stopping the movement of the cups. The spindle can be oiled by fixing a hollow knob, similar to the solid one at its upper extremity which secures it to the arms of the cups, but somewhat larger. This can be conveniently filled with oil while the cups are in motion by a hole in its top, closed by a metal peg. A very fine cut down the threads of its screw, continued to the top of the brass tube, conveys the oil down the spindle to that part, which should be cup-shaped, as should also be the upper surface of the metal under the knob. Also it is important that the glass in front of the graduated circles should be made to open on a hinge, in order that dew may be removed from its inner surface, which frequently forms there in damp misty weather and entirely prevents the circles being read. This arrangement is also necessary for the purpose of applying oil to the works. A hood of zinc or tin, covering the lower part of the instrument under the cups and projecting several inches beyond the face, assists in keeping off snow or rain, &c.

"On the Equivalent of Beaufort's Scale in Absolute Velocity of Wind." By Dr. W. Köppen, Hon.Mem.R.Met.Soc. (p. 268.)

"Note on a Peculiar Form of Auroral Cloud seen in Northamptonshire, March 1st, 1885." By the Rev. James Davis, of Banbury (Communicated by the President).

After preaching at Clipston, 5 miles from Market Harbro,' on Sunday evening, March 1st, I walked 2 miles through the fields to Oxenden, and about 8 p.m. I saw the clouds depicted in the accompanying diagram. They did not occupy the whole of the sky, but only a very considerable space, apart and alone. It was



not only a fine moonlight night, but there was an unusual splendour in the air, if such an expression may be permitted. Some days after, a jeweller showed me a beautiful oblong opal. Imagine a series of these, shaped something like a filbert (but, of course, immensely enlarged), arranged at a uniform distance from each other, and hanging in concave form on the clear blue sky, and you will have a fair idea of the group of clouds at Clipston.

June 17th, 1885.

Ordinary Meeting.

Robert H. Scott, M.A., F.R.S., President, in the Chair.

Lieut. Alexander Leeper, R.N., All Saints Rectory, King's Lynn, was balloted for and duly elected a Fellow of the Society.

The following papers were read:—

"METEOROLOGICAL OBSERVATIONS MADE ON A TRIP UP THE NILE, FEBRUARY AND MARCH, 1885." By WILLIAM MARCET, M.D., F.R.S., F.R.Met.Soc. (p. 275.)

"THE MEAN DIRECTION OF CIRRUS CLOUDS OVER EUROPE." By Dr. H. H. HILDEBRANDSSON, Hon.Mem.R.Met.Soc. (p. 287.)

"ON THE INFLUENCE OF ACCUMULATIONS OF SNOW ON CLIMATE." BY Dr. A. WOEIKOF, Hon.Mem.R.Met.Soc. (p. 299.)

"NOTE ON THE WEATHER OF JANUARY 1881." By CHARLES HARDING, F.R.Met.Soc. (p. 292.)

"RESULTS OF METEOROLOGICAL OBSERVATIONS MADE IN THE SOLOMON GROUP, 1882-84." By LIEUT. ALEXANDER LEEPER, R.N. (p. 309.)

"GRAPHIC HYGROMETRICAL TABLE, DESIGNED TO FACILITATE HYGROMETRICAL CALCULATIONS." By DAVID CUNNINGHAM, M.Inst.C.E., F.R.Met.Soc.

THE Table exhibited to the Meeting has four different sets of lines. The first represents the scale in degrees and tenths, the horizontal measurements being the degrees and tenths of the dry-bulb thermometer readings, the vertical measurements the difference in degrees and tenths between the dry and wet bulb thermometer readings. The lines of the scales are of course all straight, and drawn in the paper in yellow.

The second set of lines, namely those in red, represent the dew-point; the third set, in blue, the elasticity of the vapour; and the fourth set, in green, the relative humidity. The data are those of the well-known *Hygrometrical Tables* of James Glaisher, F.R.S., 6th Edition.

The advantage of a graphic presentation of such data lies in the great readiness and security from error with which the results can be obtained. In general, that is when decimals are present, a good deal of troublesome calculation is required when the Tables are employed; but when the proposed method is employed calculation is unnecessary, the results being read off, whenever the position has been fixed on the scale, with readiness and correctness. It is thought that the results can thus be obtained in about one-fourth of the time at present required, and with much less mental effort.

Mr. C. TODD, C.M.G., by invitation of the President, gave an account of the Meteorological Organisation in South Australia.

CORRESPONDENCE AND NOTES.

PEARSON'S COMPONENT ANEMOGRAPH.

MR. A. N. PEARSON has forwarded some remarks respecting the notice of his Component Anemograph which appeared in the *Quarterly Journal*, Vol. XI. pp. 6 and 62. He points out that the figures were intended to serve more as working drawings than as illustrative diagrams. The elaborate appearance of the drawings was increased by the presence of so many friction pulleys, which, as the whole of the friction of the machine is intended to be overcome by descending weights, might perhaps be regarded as superfluous. By the introduction of friction pulleys, the wearing of the parts of the machine one against another is considerably diminished, and consequently the machine will continue to give accurate traces for a longer time.

Mr. Pearson believes that the form of vane introduced into his instrument is both sensitive in the highest attainable degree and free from oscillation.

PRESIDENT'S ADDRESS, 1885. BY ROBERT H. SCOTT, M.A., F.R.S., PRESIDENT.

IN the List of Stations given in the Appendix to my Presidential Address, I regret that the Italian List, p. 173, was not complete. Padre F. Denza has forwarded me the following list of additional Second Order Stations, which are published in the *Bollettino Decadico* of the Osservatorio Centrale del Reale Collegio Carlo Alberto in Moncalieri.

ITALIAN STATIONS.

Station.	Altitude.	Station.	Altitude.	Station.	Altitude.
	ft.		ft.		ft.
Acireale	581	Corleone	1834	Oropa	3855
Alassio (Collegio)	98	Cotrone	33?	Pallanza	715
Alatri	1542	Cotte Valdobbia		Parma (Inst. Tecen.)	217
Alvernia	3661	Courmayeur		Piedmonte d' Alife	1900
Ampezzo	1867	Crissolo	4560	Pimzolo	2477
Anagni	1657	Empoli	148	Pinerolo	1266
Aosta	1978	Fiesole	1024	Pistoja	246
Asiago	3264	Firenze (Oss. Xim.)	249	Pontebba	1893
Aversa	213	Firenzuola	1463	Porto Venere	
Bacu-Abis	289	Gerace	1535	Pozzuoli (Comiz. Agr.)	164
Balme d' Ala	5099	Gozo [Malta]	364	„ (Solfatara)	381
Bedonia	1798	Graglia (Santuario)	2759	Recorao	
Belmonte	2375	Gran. S. Bernado		Rio Marina (Elba)	62
Biella Piazzo	1637	Grosselo		Riva	276
Bologna (Oss. Ungar.)	295	Ingurtosu	755	Roma (Univers.)	
„ (S. Luca)	948	Ivrea	948	Rovereto	650
„ (S. Luigi)		Lanzo (Collegio)	1801	Ruffano	433
Bolzonella	128	La Valletta [Malta]	85	Sacra S. Michele	3153
Bormio	4396	Le Capanne		S. Gottardo	
Boves	1995	Lendinara	39	S. Michele	801
Caldonazzo	1595	Lugliano	1335	Saluzzo	1398
Campo di Ciriè		Maenza	1175	Sampeyre	
Cannobio	689	Malè	2530	Sauris	
Carpineto		Marola	2352	Schio	666
Carrù	1171	Massalubranse		Segni	
Caselette	1440	Massa Marittima	1260	Sempione	
Cassine	604	Mineo		Spezia	221
Castel del Piano	2129	Mondragone	1427	Susa	1680
Castiglion de' Pepoli	2264	Monselice		Tolmezzo	1086
Cavalese (Oss. Denza)	3419	Montefiascone	1955	Trento	919
Cavazuccherina	23	Monte Penna	4560	Valchinsella	3609
Cavour	1040	Monteponi	656	Valenza	397
Ceresole Reale	5315	Montepulciano	1673	Varese	2828
Cingoli		Montevarchi	509	Varlungo	194
Châtillon	1745	Narni	794	Vasto	574
Chiavari	82	Napoli (Oss. Univers.)	187	Vercelli	492
Chieri	948	„ (Uff. Marina)		Verolanova	
Collio	3048	Noto		Vesuvio	2090
Conversano		Oggiono		Vilminore	3324
Coredo	2723	Ornavasso	738		

RECENT PUBLICATIONS.

AMERICAN METEOROLOGICAL JOURNAL. A Monthly Review of Meteorology and Allied Branches of Study. August-October 1885. Vol. II. Nos. 4-6. 8vo.

Contains :—A remarkable Hail Storm, by I. H. Stathem (2 pp.).—A Seven-day Weather Period, by H. H. Clayton (7 pp.).—Temperature Diagrams, by W. M.

Davis (6 pp.).—Tidal Meteorology, by P. E. Chase (1 p.).—Pneumonia and Ozone, by Dr. D. Draper (3 pp.).—The Climatology of Northern Michigan and its supposed Relation to Diseases of the Respiratory Organs, by Dr. G. H. Cleveland (5 pp.).—The Origin of the Electricity of Thunder Clouds, by A. McAdie (7 pp.).—A Preliminary Examination of Metal Thermometers, by W. A. Rogers (6 pp.).—Determination of Air Temperature, by H. A. Hazen (5 pp.). This is a reply to Dr. Wild's criticism which appeared in the Austrian *Zeitschrift für Meteorologie* for May.—On the Relations of Meteorology to Yellow Fever, by I. H. Stathem (5 pp.).—The relative value of observations of atmospheric ozone compared with those of other atmospheric conditions, and a consideration of the coincident relations of atmospheric ozone to sickness, by Dr. A. W. Nicholson (6 pp.). The author points out the importance of further investigation in this subject. Observations have long since shown that there is little ozone to be found in cities, and it is a significant fact that the death rate is greater and sickness is more prevalent in cities than in rural districts.—An Experiment in Weather Forecast, by P. E. Chase (6 pp.).

ANNUAIRE DE LA SOCIÉTÉ MÉTÉOROLOGIQUE DE FRANCE. October 1884 and January 1885. 4to.

Résumé des observations centralisées par le Service hydrométrique du bassin de la Seine, pendant l'année 1883, par H. Heude (30 pp.).—Schémas des mouvements atmosphériques entre le 30° S et le 80° N les 20 Novembre 1879 et 1er Janvier 1880, d'après les cartes d'isobares dressées par L. Teisserenc de Bort, par A. Poincaré (6 pp. and 8 plates).—Observations météorologiques anciennes faites à Tonnerre (2 pp.).—Sur un nouvel enregistreur barométrique, par G. Raymond (3 pp.).

CIEL ET TERRE. REVUE POPULAIRE D'ASTRONOMIE, DE MÉTÉOROLOGIE, ET DE PHYSIQUE DU GLOBE. Second Series, Vol. I. Nos. 11-16. August-October 1885. 8vo.

The principal meteorological contents are:—Accroissement du nombre des coups de foudre en Saxe (4 pp.).—Les trajectoires des minima barométriques, par J. Vincent (9 pp. and plate).—Les coups de foudre en Belgique pendant l'année 1884, par A. Lancaster (7 pp.).—Un nouveau traité de Météorologie (4 pp.).—De l'accord entre les indications des couleurs dans la scintillation des étoiles et les variations atmosphériques, par C. Montigny (8 pp.).—Les dernières recherches sur l'électricité atmosphérique (8 pp.).—Études d'optique atmosphérique, par E. Lagrange (7 pp.).

INDIAN METEOROLOGICAL MEMOIRS: being occasional Discussions and Compilations of Meteorological Data relating to INDIA AND THE NEIGHBOURING COUNTRIES. Published under the direction of HENRY F. BLANFORD, F.R.S., Meteorological Reporter to the Government of India. Vol. II. Part IV. 4to. 232 pp. and 7 plates. 1885.

This is devoted to an Account of the South-west Monsoon Storms generated in the Bay of Bengal during the years 1877 to 1881, by J. Eliot, M.A. The first portion of the paper gives a list and a brief account of a large number of storms which originated in the Bay of Bengal and passed landwards. It establishes fully that cyclonic storms form a regular and frequent feature of the whole South-west Monsoon period. The history of the forty-six cyclones included in the Report shows fully that they were all accompanied by heavy rainfall, and that they all brought up more or less humid winds, for considerable periods, to the districts in the rear of the cyclone; so that each cyclonic disturbance preceded a burst of Monsoon rains over a portion of the Empire. Hence their occurrence is of considerable importance in connection with the distribution of rainfall during the South-west Monsoon in India. The history also roughly shows that the severest cyclones (as, for example, the Vizagapatam cyclone of November 1878 and the Negapatam cyclone of November 1880, in each of which the depression exceeded half an inch) were associated with the most concentrated and localised rainfall. The same fact is also indicated more or less clearly by the history of the storms. There is always heavy localised rainfall

over the area of cyclonic disturbance, and the strength and character of the disturbance depend to a very large extent upon the amount and character and distribution of the rainfall.

JOURNAL OF THE ASIATIC SOCIETY OF BENGAL. Vol. LIV. Part II. No. 1. 1885. 8vo.

Contains :—On Observations of the Solar Thermometer at Lucknow, by S. A. Hill (16 pp.). The observations show that in a dry year the solar thermometer will give higher indications than in a damp one, when due allowance is made for variations in atmospheric absorption. The conclusion the author draws from this investigation is, that while the results indicate a rather strong presumption in favour of the hypothesis that the emission of solar heat varies inversely with the number of sun spots, the hypothesis can only be definitely proved by observations of some kind of actinometer which is protected from reflection, and receives direct solar rays only. Probably the form of instrument which will be found most useful is a thermopile, turned by clockwork so as to face the sun, and attached to a reflecting galvanometer, by means of which the heating effect can be photographically recorded.

JOURNAL OF THE SCOTTISH METEOROLOGICAL SOCIETY. Third Series, No. II. 8vo. 1885.

Contains:—The Climate of the British Islands (Third Paper), by A. Buchan (22 pp. and plate). This is a discussion of the annual rainfall for the twenty-four years 1860 to 1883. Tables are given showing for 1080 stations in England and Wales, 547 in Scotland, and 213 in Ireland—the height above sea-level; the number of years rain has been recorded; these years specified; the mean annual rainfall for these years; and the calculated mean rainfall for the twenty-four years 1860-83.—Meteorology of Ben Nevis for the year ending 31st May, 1885, by A. Buchan (10 pp.).—The Meteorology of Culloden, Inverness-shire, from Observations made from January 1841 to December 1880 by the late A. Forbes, by A. Buchan (20 pp.).—Anemometrical Observations at Dundee, by D. Cunningham (2 pp.).—Meteorology of San Jorge, Central Uruguay, from Four Years' Observation, by A. Buchan (5 pp.).—On the Formation of Snow Crystals from Fog, by R. T. Omond (2 pp.).—Statistics of the Annual Rainfall for Twenty-seven Years, 1858-84, in the District of Cape S. Antonio, South America, Province of Buenos Ayres, by T. Gibson (2 pp.).

METEOROLOGISCHE ZEITSCHRIFT. Herausgegeben von der Deutschen Meteorologischen Gesellschaft. Redigirt von Dr. W. KÖPPEN. Zweiter Jahrgang, 1885. Parts 7-9, July-September. 4to.

Contains:—Die magnetische Landes-Aufnahme von Canada durch Gen. Sir J. H. Lefroy, 1842-44, von Dr. G. Neumayer (7 pp.).—Ueber Reduktion von Barometer-ständen auf das Meeresniveau, von C. Schultheiss (7 pp.). The author points out that all Bavarian stations lie above the level of 1,000 feet, for which the sea-level reduction was stated to be allowable by the Congress at Rome. He recommends that the readings should be telegraphed for Weather Reports unreduced, and that the reduction when carried out should be made in steps, reducing each station to the next lowest adjacent station so as to have some idea of the temperature of the air column.—Lemströms Beobachtungen auf den Polarstationen zu Sodankylä und Kultala in Finnisch-Lappland 1882-84 (6 pp.).—Ueber das Sättigungsdeficit, von Prof. K. Weihrauch (4 pp.).—Ueber die Darstellüng der stündlichen und jährlichen Vertheilung der Temperatur durch ein einziges (Thermo-Isoplethen) Diagramm und dessen Verwendung in der Meteorologie, von Dr. F. Erk (19 pp.). This paper points out the great advantages which the method of chrono-isothermals (of Lalanne) presents, and suggests that they should be termed *isopleths*, "equal values."—Tägliche Veränderung des Luftdrucks in den Cyklonen, von J. Vincent (7 pp.). This paper shows how frequently the minimum barometer reading in cyclonic systems falls about 4 a.m., and the maximum in anticyclones about 10 a.m.—Ueber die Fortschritte der wissenschaftlichen Witterungskunde während der letzten Jahrzehnte, von W. v. Bezold (2 pp.). This is an address delivered at the Meeting of the German Meteorological Society at Munich, in which the author

discusses not only the advances made recently, but also the relative merits of Brandes and Dove respectively to be considered as the first indicator of the proper mode to be followed in weather study.—Bemerkungen über die Beziehung der mittleren Bewölkung zur Anzahl der heiteren und trüben Tage, von Dr. V. Kremser (9 pp.).

Minutes of Proceedings of the Institution of Civil Engineers, Vol. LXXXI., Session 1884-5. Part 3. 8vo. 1885.

Contain:—The River Buffalo; total flow at the Town Dam, King William's Town, Cape of Good Hope, from June 1880 to March 1883, compared with the Rainfall, by W. B. Tripp (11 pp.).

Ocean and Air Currents. By Thomas D. Smellie. 8vo. 1885. 21 pp.

The general conclusion of the author is, that as by experiments it has been found that water resting on a revolving solid body, if freely under the influence of gravitation and the revolving force, does not throughout all of its depth acquire an equal speed with the solid body, but lags behind near the surface, it may fairly be inferred that earth and ocean, being under the same forces in the diurnal rotation, should be affected in a similar manner. The backward flow being greatest where the speed is highest, or round the equatorial belt, will produce the dominant current, the others being return currents by gravitation to keep up the supply.

Proceedings of the Chester Society of Natural Science. 1884. Part III. 8vo.

Contains a very interesting paper (7 pp.) by Mr. A. O. Walker on the Climate of the Chester District (including Denbighshire and Flintshire) considered in relation to Fruit Growing. There is a very widespread belief that the principal factor in determining the crop of tree fruit, viz. Pears, Apples, Cherries, and Plums, is the amount of frosts in spring when the trees are in blossom. If this were the case, then the West coast of England, Wales, Scotland, and still more of Ireland would be the most favourable climate, not only in the British Islands, but of all Europe, north of, say lat. 45°, for growing fruit, and North America, except the Southern States, would not have a chance against us with their rigorous winters. Yet as a matter of fact we find that precisely those countries that have the coldest winters are the greatest producers of the above tree fruits, and that those like our own West coasts, that have a mild equable climate, produce the least. This clearly points to some other cause than the above as determining the suitability of any given area for the production of fruit, and there can be little doubt that this will be found to be the summer temperature, and that the higher this is the better for this purpose. And inasmuch as a country having a dry atmosphere, which offers less resistance to the radiation of heat from the sun to the earth on the one hand, and from the earth into space on the other, than a moist one, will have at once hotter summers and colder winters than a moist country, it follows that the further we go from the breezes which reach our Western coasts with moisture from their long sweep over the Atlantic, the more profitable will it be found to plant fruit trees, other conditions of course being equal; hence it comes that we find ourselves supplied with Apples from America and Pears from the interior of France, in both of which countries the heat in summer and the cold in winter are much greater than in this country.

Proceedings of the Literary and Philosophical Society of Liverpool during the Seventy-third Session, 1883-84. No. XXXVIII. 8vo. 1884.

Contains:—Ship Anemometer, by W. G. Black (4 pp. and plate). The principle of the anemometer is derived from the sail of a ship, the pressure of the wind upon which is transmitted by a cord going under a pulley to a pointer moving on a scale similar to that of a common spring-balance.

Proceedings of the Philosophical Society of Glasgow. Vol. XVI. 1884-1885. 8vo. 1885.

Contains:—A Theory of Storm Travel, by P. Alexander, M.A. (8 pp.). The speculations in this paper were entered upon by the author after reading the two

articles entitled "Weather Forecasts" which appeared in *Good Words* about three years ago. The author's theory of storm travel is that both cyclones and anticyclones, when undisturbed by external causes, must travel eastward.

Proceedings of the Royal Society. Vol. XXXVIII. No. 236. 8vo. 1885.

Contents :—On Underground Temperatures, with observations on the conductivity of rocks, on the thermal effects of saturation and imbibation, and on a special source of heat in mountain ranges, by Prof. J. Prestwich, F.R.S. (7 pp.). The author deduces from the three classes of observations a general mean of thermic gradient of 48 feet per degree Fahr., but he considers this only an approximation to the true normal gradient, and that the readings of the coal mines and artesian well experiments are owing to the causes he enumerates still too high. He also discusses the question whether or not the gradient changes with the depth. His own reduction of the observations gave no result, but he points out that in all probability the circulation of water arising from the extreme tension of its vapour is stayed at a certain depth; while as it is known experimentally that the conductivity of iron diminishes rapidly as the temperature increases, this may possibly in a different degree apply to rocks. If therefore there is any change, these indications would be in favour of a more rapid gradient. Taking all these conditions into consideration, the author inquires whether a gradient of 45 feet per degree may not be nearer the true normal than even the one of 48 feet obtained by the observations.

Report on the Meteorology of India in 1883. By Henry F. Blanford, F.R.S., Meteorological Reporter to the Government of India. Ninth Year. 4to. 1885.

The year 1883 was characterised in the Indian area, on the whole, by a low temperature, a mean pressure also slightly below the average, a smaller proportion of water vapour, rendering the atmosphere both relatively and absolutely drier than on the average of past years; but, on the other hand, a slight excess of cloud, and a rainfall more than usually copious in most parts of the peninsula, and less than the normal amount in the greater part of Northern India, the excess of one region almost exactly compensating the deficiency of the other.

Mr. Blanford in the introduction remarks that a recent investigation of the records of rainfall for the past twenty years has brought to light some peculiarities in the relative precariousness of the rainfall in different parts of India which have much interest both from an economic and a scientific point of view, and their detection may prove to be only the first step towards a more complete explanation of the meteorological and geographical conditions which determine the occurrence of drought and famine. As a general rule, the rainfall is most variable in those regions where the average rainfall is smallest, such as are Sind and Cutch, and the desert track of Western Rajputana; and least so in the tracts of heaviest rainfall. It has been shown in former Reports, more especially that for 1878, that years of severe and prolonged drought have been those in which the pressure of the atmosphere has been unduly high, and there is in all probability a direct connection between this condition and the persistence of the dry winds in those years. But there is evidently some other condition which operates in producing these winds, and in retarding or interrupting the rainfall in years such as 1883, when the atmospheric pressure does not exceed the average, and may even be below it. The dry winds in such seasons are less lasting, but for a time they are as strongly marked as in famine years. Mr. Blanford believes that in such cases they are due to an unusual extent and thickness of snow on the North-western Himalaya.

Results of the Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich, in the year 1883: under the direction of W. H. M. Christie, M.A., F.R.S., Astronomer-Royal. 4to. 1885. 133 pp. and 18 plates.

In addition to the daily observations, &c. tables are given showing the monthly means at every hour, of the barometer, dry and wet bulb thermometers,

dew-point, relative humidity, amount of sunshine, velocity of the wind, and the electrical potential of the atmosphere. The following are the principal results for 1883 :—Temperature, mean 49°·4, highest 85°·1, on August 21st; lowest 20°·6 on March 24th ; mean daily range 15°·6 ; Wind, mean daily pressure on the square foot 0·75 lb., greatest pressure 28·5 lbs. on February 2nd ; mean daily velocity 291 miles, greatest velocity 842 miles on December 12th, least velocity 62 miles on December 26th ; Rain, total 21·909 ins., No. of rainy days 173 ; Sunshine, total duration 1240·8 hours.

SITZUNGSBERICHTE DER KAISERLICHEN AKADEMIE DER WISSENSCHAFTEN (Vienna). Band XCII. Abth. II. June 1885. 8vo.

Contains :—Die Temperaturverhältnisse der österreichischen Alpenländer, by Dr. J. Hann (166 pp.). This is the author's third and concluding paper on this subject.

SYMONS'S MONTHLY METEOROLOGICAL MAGAZINE. Vol. XX. Nos. 235-237. August-October 1885. 8vo.

The principal articles are :—The *Times* on the Drought and on the Rainfall Organisation (4 pp.).—Atmospheric Electricity, by J. R. Capron (4 pp.).—Meteorology at the Inventions Exhibition (7 pp.).—The Drought of July 1885 (4 pp.).—The Rainband vindicated, by J. R. Capron (4 pp.).

THE GARNER AND SCIENCE RECORDERS' JOURNAL. Edited by A. RAMSAY, F.G.S. Vol. I. No. 1. October 1885. 8vo.

This new publication is devoted to the interests of Science and Scientific works in general, but more especially to those of the small Natural History Societies. Its object is to foster and encourage every attempt made to organise systematic investigation, both by individuals and confederations of Societies. The present No. contains articles on the following subjects:—Our Natural History Societies (3 pp.).—Phenological Stations (3 pp.).—The Mollusca of Surrey, by E. H. Rowe (4 pp.).

TRANSACTIONS AND PROCEEDINGS AND REPORT OF THE ROYAL SOCIETY OF SOUTH AUSTRALIA. Vol. VII. 1883-84. 8vo. 1885.

Contains:—Remarks on the "Red Glow," by C. L. Wragge (7 pp.).—Notes on the Crepuscular Glimmer, or Red Glow, by W. A. Jones (11 pp.).

ZEITSCHRIFT DER ÖSTERREICHISCHEN GESELLSCHAFT FÜR METEOROLOGIE. Redigirt von Dr. J. HANN. Band XX. August-October 1885. 8vo.

Contains:—Das Klima des nordwestlichen Himalaya und die Temperatur in N.W. Indien, nach S. A. Hill (16 pp. and plate).—Stündliche Beobachtungen auf Pike's Peak, Mount Washington, und den entsprechenden Fuss-stationen, von Dr. J. M. Pernter (6 pp.). The author discusses the hourly observations at Pike's Peak and Mount Washington, which have been published in the *Report of the Chief Signal Officer*, 1882, for the day hours.—Die meteorologische Gipfelstation Hochobir im Winter, von Dr. J. M. Pernter (2 pp. and plate).—Ueber eine Eigenthümlichkeit des Seehorizontes, von E. Budde (7 pp.). This is a notice of the frequent distortion of objects seen at sea, usually called refraction, when small islands, &c. appear floating in the air. The author attributes this to the reflection of light from wave tops. He says that it is far more remarkable when there is some sea than when the surface is quite calm.—Zum Klima von Tabor, von F. Hromádko (5 pp.).

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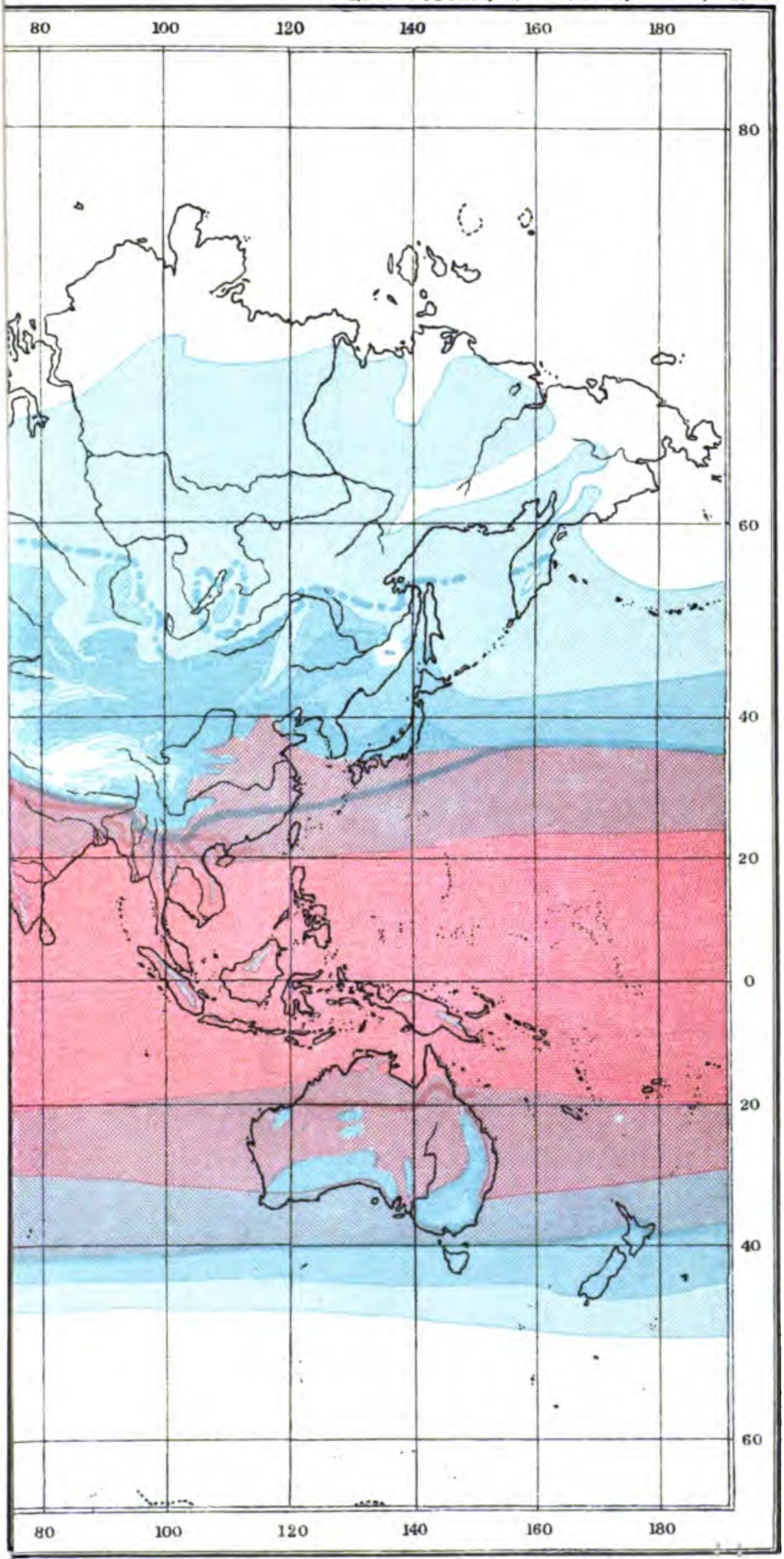
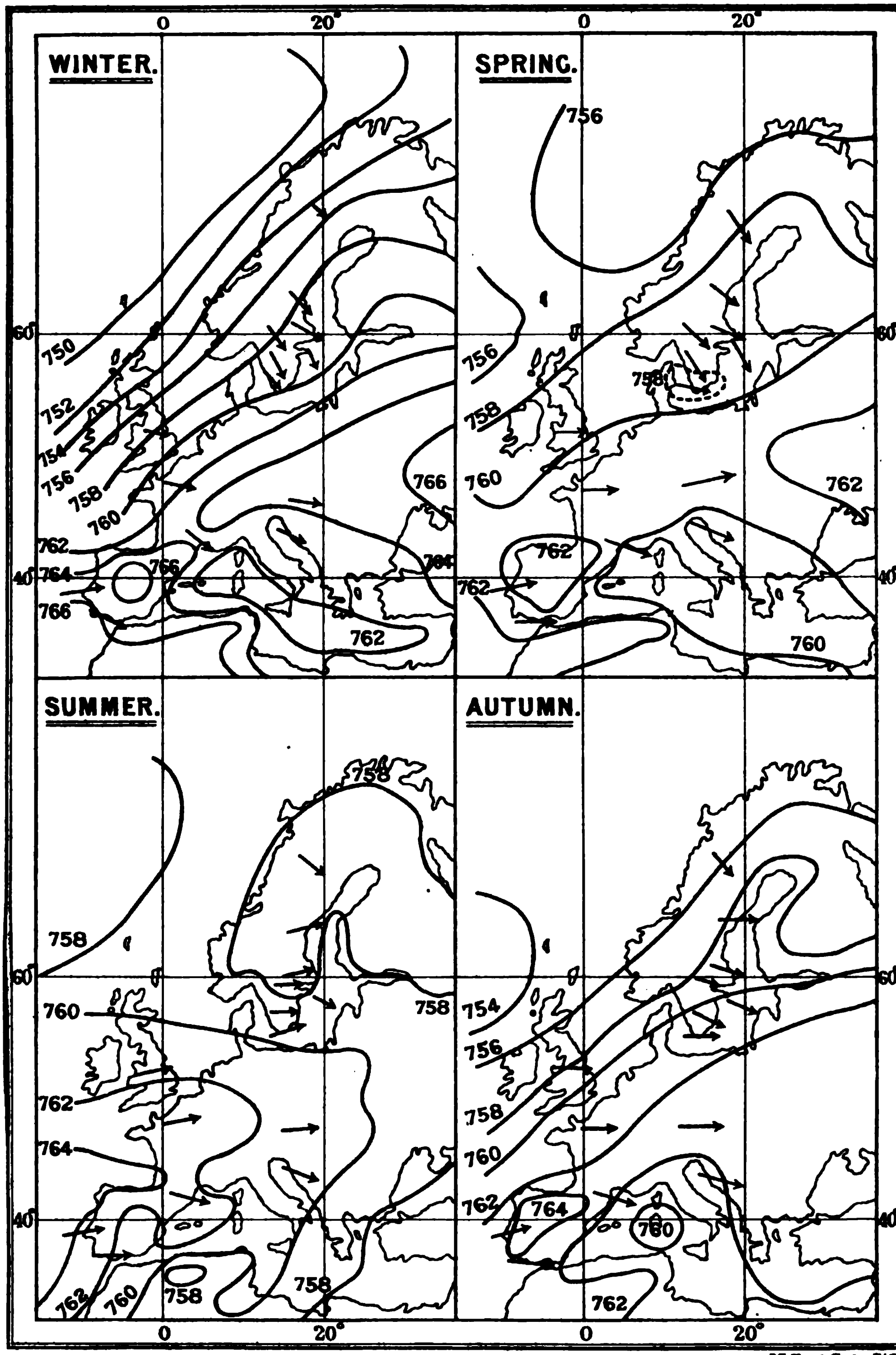
THE END.



-iod (below 20° C.) embracing 4 months.

ISOBARS AND DIRECTION OF CIRRUS CLOUDS OVER EUROPE.



Malby & Sons, Lith.

METEOROLOGY OF ENGLAND,

DURING THE QUARTER ENDING DECEMBER 31, 1884.

REMARKS ON THE WEATHER DURING THE QUARTER ENDING DEC. 31ST, 1884.

By JAMES GLAISHER, ESQ., F.R.S., *&c.*

The weather in October was remarkably fine and dry; the temperature, with the exception of the few days from the 9th to the 13th, was generally above the average with a good deal of sunshine. The pressure of the atmosphere with the exception of the few days, the 8th to the 12th and 26th, 27th, and 28th, was above the average, and the mean pressure for the month, was higher than in any month since January. The fall of rain was small being a good deal below the average, the land generally was too dry for sowing, and the scarcity of water caused inconvenience in many places; there were scarcely any storms, and a marked deficiency of S.W. winds, and an excess of N.W.

The weather in November, during the first half of the month was warm and bright, the last half was cold, particularly the 24th and 25th. The pressure of the atmosphere with the exception of a very few days was above the average, and the mean pressure for the month was the highest in the year. The fall of rain was small generally, and the land was still dry; there was again a great deficiency of S.W. winds, and the month was almost free from storms.

The weather in December, with the exception of the first two days, was mild till the 20th, and from the 21st the temperature was below the average. The atmospheric pressure was generally below the average till the 20th, and was alternately above and below the average from the 21st, the sky was generally cloudy; rain fell frequently till the 20th, and it was generally in excess of the average. Thunderstorms occurred on two days, and snow fell on 12 days, chiefly in the Midland counties.

About London the mean daily temperature of the air for the 1st day in October was above its average by 1°·0, the mean deficiency of the next four days was 2°·2 daily, the 6th and 7th days were slightly in excess of their averages, there was then a week of very cold weather, the deficiency averaging 6°·3 daily; from the 15th to the 19th the daily excess was 4°·2; from the 20th the mean temperature was below with but few exceptions till the 29th, the deficiency being 1°·0 daily. For fifteen days ending November 13th the excess of mean temperature was 3°·9. From November 14th to December the 2nd the weather was cold the deficiency being 4°·3. From December 3rd to the 20th the mean temperature was high, the excess over the average being 3°·6 daily, and for the last 11 days in the year the daily deficiency was 1°·9.

The mean temperature of the air for October was 48°·9, being 0°·6 and 1°·1 below the averages of 113 years and 43 years respectively; it was 1°·5 and 1°·9 lower than in 1883, and 1882, and 3°·6 higher than in 1881.

The mean temperature of the air for November was 42°·4, being 0°·1 above the averages of 113 years and 1°·1 below the average of 43 years; it was 1°·4, 1°·1, and 6°·3 lower than in 1883, 1882, and 1881 respectively.

The mean temperature of the air for December was 41°·0, being 1°·9 and 1°·1 above the averages of 113 years and 43 years respectively; it was 0°·5, 0°·9, and 1°·2 higher than in 1883, 1882, and 1881 respectively.

The mean temperature of the quarter was 44°·1, being 0°·5 higher than the average of 113 years and 0°·4 lower than the average of 43 years.

The mean high day temperatures of the air in October was 56°·5, being 1°·6 below the average of 43 years, in November it was 47°·6, being 1°·3 below the average, and in December it was 45°·1, being 0°·4 above the average.

The mean low night temperatures of the air in October was 41°·6, being 1°·9 below the average of 43 years; in November it was 36°·8, being 0°·5 below the average, and in December it was 36°·5, being 1°·3 above the average.

The mean daily range of temperature in October was 14°·9, being 0°·3 greater than the average; in November it was 10°·8, being 0°·7 smaller than the average, and in December it was 8°·6, being 0·8 smaller than the average.

The mean temperature of the air for October was 10°·4 lower than in September, in November it was 6°·5 lower than in October, and in December it was 1°·4 lower than in November.

(From the preceding 43 years' observations the decrease of temperature from September to October is 7°·1, the decrease from October to November is 6°·5, and the decrease from November to December is 3°·6.)

From September to October there was a decrease of temperature at stations south of 51° of 7°·0, between 51° and 52° of 9°·8, between 52° and 53° of 9°·6, between 53° and 54° of 8°·6; and north of 54° of 7°·7.

From October to November there was a decrease of temperature at stations south of 51° of 6°·3, between 51° and 52° of 6°·7, between 52° and 53° of 6°·8, between 53° and 54° of 5°·8, and north of 54° of 7°·7.

From November to December there was a decrease of temperature at stations south of 51° of 3°·2, between 51° and 52° of 1°·3, between 52° and 53° of 1°·8, between 53° and 54° of 2°·9, and north of 54° of 2°·3.

1884. Months.	Temperature of Air. Mean.	Air. Diff. from average of 113 years.	Air. Diff. from average of 43 years.	Evaporation. Mean.	Evaporation. Diff. from average of 43 years.	Dew Point. Mean.	Dew Point. Diff. from average of 43 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 43 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 43 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 43 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	grs.
Oct. -	48·9	−0·6	−1·1	46·4	−1·6	43·7	−2·2	14·9	+0·3	0·285	−0·026	3·2	−0·7
Nov. -	42·4	+0·1	−1·1	40·5	−0·9	38·3	−1·1	10·8	−0·7	0·231	−0·015	2·7	−0·2
Dec. -	41·0	+1·9	+1·1	39·3	+0·8	37·2	+0·6	8·6	−0·8	0·222	+0·003	2·6	0·0
Means -	41·1	+0·5	−0·4	42·1	−0·6	39·7	−0·9	11·4	−0·4	0·216	−0·013	2·8	−0·3

1884. Months.	Degree of Humidity. Mean.	Humidity. Diff. from average of 43 years.	Reading of Barometer. Mean.	Barometer. Diff. from average of 43 years.	Weight of a Cubic Foot of Air. Mean.	Weight. Diff. from average of 43 years.	Rain. Amount.	Rain. Diff. from average of 69 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
Oct. -	83	− 5	29·895	+0·185	544	+ 4	1·04	−1·79	294	9	18	4	25·6	46·1
Nov. -	85	− 3	29·978	+0·237	553	+ 5	0·99	−1·36	260	16	9	5	17·5	44·9
Dec. -	87	− 2	29·690	−0·102	519	− 3	2·51	+0·56	430	6	23	2	20·9	46·7
Means -	85	− 3	29·854	+0·043	549	+ 2	Sum 4·57	Sum −2·59	Mean 328	Sum 31	Sum 50	Sum 11	Lowest 17·5	Highest 46·7

NOTE.—In reading this table it will be borne in mind that the sign (+) signifies *above* the average, and the minus sign (−) signifies *below* the average.

Average duration of the different directions of the wind referred to eight points of the compass, and duration of each direction in each month in the quarter, were as follows:—

Direction of Wind.	October. 1884.	October. Average.	October. Departure from Average.	November. 1884.	November. Average.	November. Departure from Average.	December. 1884.	December. Average.	December. Departure from Average.
	d.	d.	d.	d.	d.	d.	d.	d.	d.
N.W.	7½	2½	+ 6	5¾	2¼	+3½	3¼	2¼	+1
N.	2¼	3¾	− 1½	1¾	4½	−2¾	3¾	3	+ ¾
N.E.	2¾	3	− ¼	2¾	4	−1¼	2½	2½	0
E.	3	1⅔	+ 1⅓	3½	2¼	+1¼	5½	2	+3½
S.E.	¾	2	− 1¼	1¼	2	− ¾	1	2	−1
S.	2	4	− 2	3¼	4	− ¾	2	3½	−1½
S.W.	3¼	10	− 6¾	2¼	8½	−6¼	8½	11	−2½
W.	7⅔	4⅓	+ 3⅓	7¼	2½	+4¾	4½	4½	0
Calm.	1⅓	0	+ 1⅓	2	0	+2	0	0	0

The plus sign (+) denotes excesses over averages; the largest numbers affected with this sign in the month of October are opposite to N.W. and W.; in November to W. and N.W.; and in December to E. and N.W.

The minus sign (−) denotes deficiencies below averages. In October the largest numbers are opposite to S.W. and S.; in November to S.W. and N.; and in December to S.W. and S.

The mean reading of the barometer for the month of October at the height of 160 feet above the level of the sea was 29·895 ins., being 0·185 in. higher than the average of 43 years, and being 0·095 in., 0·239 in., and 0·068 in. higher than in 1883, 1882, and 1881 respectively.

The mean reading of the barometer for the month of November was 29·978 ins., being 0·237 in. above the average of 43 years, and being 0·319 in., 0·446 in., and 0·193 in. higher than in 1883, 1882, and in 1881 respectively.

The mean reading of the barometer for the month of December was 29·690 ins., being 0·102 in. below the average of 43 years, and being 0·293 in. lower than in 1883, 0·197 in. higher than in 1882, and 0·131 in. lower than in 1881.

From September to October there was an increase of pressure at stations south of 51° of 0·098 in., between 51° and 52° of 0·065 in., between 52° and 53° of 0·044 in., between 53° and 54° of 0·051 in., and north of 54° of 0·056 in.

From October to November there was an increase of pressure at stations south of 51° of 0·054 in., between 51° and 52° of 0·086 in., between 52° and 53° of 0·100 in., between 53° and 54° of 0·091 in., and north of 54° of 0·102 in.

From November to December there was a decrease of pressure at stations south of 51° of 0·251 in., between 51° and 52° of 0·286 in., between 52° and 53° of 0·317 in., between 53° and 54° of 0·328 in., and north of 54° of 0·363 in.

About London the barometric pressure till October 7th, was above the average by 0·39 in. daily; from the 8th to the 12th it was below by 0·22 in. daily; for 13 days there was an excess of mean daily pressure to the amount of 0·31 in.; then for 3 days a daily deficiency of 0·20 in. From October 29th the pressures were above their averages, with but few slight exceptions till November 27th, the average daily excess of these 30 days being 0·26 in. From November 28th to December 20th, the pressure was generally below its average, the mean daily deficiency being 0·17 in.; from the 21st the pressure was alternately on 2 or 3 days a little above the average, and then on 2 or 3 days a little below.

Thunderstorms occurred in October on the 9th at Barnet and Oxford; on the 21st at Salisbury; and on the 26th at Carlisle.

In November on the 4th at Silloth.

In December on the 18th at Totnes, Ventnor and Nottingham; on the 19th at Torquay.

Thunder was heard but lightning was not seen in October, on the 24th at Carlisle.

In December on the 17th at Bolton; and on the 19th at Bath.

Lightning was seen but thunder was not heard in October, on the 10th at Torquay; on the 11th at Guernsey; and on the 14th at Halifax.

In November on the 20th at Carlisle.

In December on the 4th at Burslem and Lancaster; on the 12th and 13th at Carlisle; on the 18th at Plymouth and Torquay; on the 26th at Guernsey.

Solar halos were seen in October on the 1st at Halifax; on the 3rd at Torquay and Halifax; on the 4th, 7th, 11th, 12th, and 19th at Halifax; on the 24th at Leicester; on the 25th at Torquay and Oxford; on the 26th, 27th, 28th, 29th, 30th, and 31st at Halifax.

In November, on the 1st, 3rd, 4th, 5th, 7th, 8th, and 9th at Halifax; on the 10th at Oxford and Halifax; on the 13th and 14th at Halifax; on the 15th at Oxford; on the 22nd, 23rd, 25th, and 26th at Halifax; on the 28th at Oxford and Halifax; on the 29th at Halifax.

In December on the 2nd at Torquay; on the 5th, 6th, 15th, 16th, 20th, and 22nd at Halifax.

Lunar halos were seen in October on the 2nd at Oxford; on the 3rd at Torquay and Oxford; on the 28th at Torquay; on the 29th at Guernsey, Torquay, Halifax, and Stonyhurst.

In November on the 2nd at Hull; on the 3rd at Torquay and Halifax; on the 4th at Marlborough and Oxford; on the 25th and 26th at Halifax; and on the 29th at Torquay.

In December on the 1st at Torquay; on the 2nd and 3rd at Oxford; on the 3rd at Cambridge and Halifax; on the 4th at Torquay; on the 6th at Bolton; on the 30th at Bradford; and on the 31st at Royston and Cambridge.

Snow fell in October, on the 9th at Bolton and Carlisle; on the 10th at Torquay, Rugby, Leicester, Burslem, Bolton, and Halifax; on the 26th at Halfax.

In November, on the 17th at Burslem; on the 18th at Royston, on the 20th at Oxford; on the 22nd at Marlborough; on the 24th at Barnet, Oxford, Cardington, Rugby, Burslem, Bolton, and Halifax; on the 25th at Marlborough, Oxford, Rugby, Wolverhampton, Nottingham, Burslem, and Halifax; on the 28th at Burslem; on the 29th at Torquay, Osborne, Marlborough, Royston, Lowestoft, and Somerleyton; on the 30th at Totnes, Barnet, Oxford, Royston, Cardington, Somerleyton, Nottingham, Burslem, Bolton, Halifax, Bradford, and Leeds.

In December, on the 1st at Blackheath, Barnet, Royston, Cambridge, Burslem, Bolton, Hull, and Lancaster; on the 15th at Bolton; on the 17th at Totnes, Torquay, Whitchurch, Royston, Cambridge, Rugby, Nottingham, Burslem, Bolton, Halifax, and Bradford; on the 18th at Oxford, Royston, Cambridge, Lowestoft, Nottingham, Burslem, Halifax, and Hull,; on the 19th at Halifax; on the 20th at Whitchurch, Royston, Cambridge, Rugby, Nottingham, and Burslem; on the 23rd at Torquay, Ventnor, and Barnet; on the 24th at Burslem; on the 25th at Whitchurch, Barnet, Oxford, Royston, Cambridge, Rugby, and Burslem; on the 26th at Bath and Rugby; on the 27th at Cambridge; and on the 30th at Oxford.

Hail fell in October, on the 8th at Truro; on the 9th at Guernsey; on the 10th at Totnes, Torquay, Whitchurch; on the 11th at Guernsey; on the 12th at Guernsey and Plymouth; on the 26th at Rugby, Bolton, Halifax, and Bradford; on the 28th at Bolton; on the 29th at Bolton and Halifax.

In November, on the 7th at Stonyhurst; on the 24th at Lowestoft, on the 28th at Truro, Whitchurch, Oxford; on the 29th at Truro.

In December, on the 3rd at Truro; on the 4th at Guernsey, Truro, Totnes, Torquay, Bath, Blackheath, Rugby, Bolton, Halifax, Lancaster; on the 7th at Bath; on the 9th at Halifax; on the 15th at Bolton and Halifax; on the 17th at Truro, Totnes, Torquay, Bolton; on the 18th at Guernsey, Royston, Bolton, Halifax; on the 19th at Truro and Bath; on the 20th at Torquay, Bath; on the 24th at Lowestoft; on the 25th at Guernsey; on the 30th at Llandudno.

MONTHLY METEOROLOGICAL TABLE FOR THE QUARTER ENDING DECEMBER 31st, 1884.

The Observations have been reduced to Mean values by Glaisher's Barometrical and Diurnal Range Tables, and the Hygrometrical results have been deduced from the sixth edition of his Hygrometrical Tables.

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884.	Pressure of Atmosphere in Month.		Temperature of Air in Month.						Mean Temperature.		Vapour.					Mean Reading of Thermometer.		Wind.					Mean Amount of Ozone.	Mean Amount of Cloud.	Rain.	
								Mean						In a cubic foot of Air.							Relative Proportion of							
		Months.	Mean.	Range.	Highest.	Lowest.	Range.	Of all Highest.	Of all Lowest.	Daily Range.	Air.	Dew Point.	Elastic Force.	Mean.	Short of Saturation.	Mean Degree of Humidity. Sat. = 100.	Mean Weight of a cubic foot of Air.	Maximum in Rays of Sun.	Minimum on Grass.	Estimated Strength.	N.	E.	S.	W.			Number of Days it fell.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									
GUERNSEY, Adolphus Collenette, Esq., F. R. Met. Soc.	270	Oct.	29·846	1·180	61·8	40·0	21·8	57·1	48·3	8·8	52·2	45·1	·301	3·4	1·1	75	510	96·0	41·5	0·9	11	5	8	12	1·5	6·3	20	2·19
		Nov.	29·878	0·698	59·6	31·9	27·7	50·4	43·2	7·2	45·4	40·5	·253	2·9	0·8	81	547	78·8	37·8	0·8	11	7	6	6	0·9	6·5	17	2·03
		Dec.	29·638	1·210	55·0	35·0	20·0	47·7	41·0	6·7	44·9	37·8	·247	2·6	0·8	74	544	65·2	37·4	1·5	6	6	4	15	3·4	8·1	26	7·87
TRURO (Cornwall), C. Barham, Esq., M.D., F. R. Met. Soc.	43	Oct.	29·986	1·335	65·0	32·0	33·0	58·9	45·8	13·1	51·2	47·1	·324	3·6	0·7	86	548	—	—	2·1	8	4	3	16	—	7·3	18	2·20
		Nov.	30·025	0·810	61·0	28·0	33·0	52·0	40·2	11·8	45·6	41·5	·264	2·9	0·6	86	551	—	—	2·1	7	8	5	10	—	7·2	19	2·58
		Dec.	29·796	0·760	56·0	28·0	28·0	49·0	39·1	9·9	44·4	41·2	·259	2·9	0·4	89	548	—	—	2·6	8	5	5	13	—	7·7	20	3·97
PLYMOUTH (Devon), J. Merrifield, Esq., LL.D., F.R.A.S., F. R. Met. Soc.	69	Oct.	30·056	1·336	62·5	34·0	28·5	55·4	44·2	11·2	50·0	45·7	·307	3·5	0·6	85	543	—	—	1·3	11	4	5	11	—	7·1	17	1·61
		Nov.	30·107	0·817	58·8	29·8	29·0	51·0	40·4	10·6	45·0	42·0	·266	3·0	0·4	89	553	—	—	1·1	6	9	7	8	—	7·0	17	1·67
		Dec.	29·883	0·929	55·1	31·5	23·6	48·1	39·0	9·1	43·6	40·1	·245	2·8	0·4	87	550	—	—	1·5	6	7	6	12	—	8·2	21	3·54
TOTNES (Devon), T. H. Edmonds, Esq.	107	Oct.	30·049	1·321	64·8	29·2	35·6	58·6	42·5	16·1	50·1	45·4	·304	3·4	0·6	84	546	—	—	2·1	12	3	3	11	—	6·1	14	1·27
		Nov.	30·119	0·771	61·1	23·9	37·2	51·2	37·5	13·7	44·5	41·6	·264	3·1	0·3	90	551	—	—	1·9	9	5	7	9	—	7·6	15	2·15
		Dec.	29·879	0·928	55·0	29·2	25·8	46·6	37·2	9·4	42·7	39·0	·237	2·7	0·4	93	551	—	—	3·4	6	3	8	14	—	7·6	20	6·01
TORQUAY, Babbacombe (Devon), Edwin E. Glyde, Esq., F. R. Met. Soc.	305	Oct.	29·802	1·472	63·6	36·3	27·3	57·0	45·5	11·5	50·9	45·0	·299	3·4	0·8	81	540	101·9	36·2	1·3	8	4	6	13	3·8	6·4	13	0·90
		Nov.	29·841	0·798	58·7	26·5	32·2	49·9	40·9	9·0	45·5	40·7	·255	3·0	0·5	85	547	77·5	34·0	1·5	7	6	8	9	3·5	7·7	14	1·55
		Dec.	29·591	1·263	53·7	31·1	22·6	46·5	38·5	8·0	42·9	38·3	·232	2·6	0·6	85	546	64·9	32·0	1·9	5	6	7	13	5·1	7·7	20	3·75
VENTNOR, (Isle of Wight) (Royal National Hospital for Consumption), Hartley Sagar, Esq.	80	Oct.	29·983	1·188	64·2	36·4	27·8	59·0	47·3	11·7	52·1	45·8	·309	3·5	0·8	79	542	—	—	1·2	10	5	4	12	5·4	5·3	12	1·26
		Nov.	30·054	0·778	61·7	29·5	32·2	50·6	42·3	8·3	44·2	37·8	·227	2·6	0·9	82	554	—	—	1·7	11	6	6	7	4·1	6·3	7	0·53
		Dec.	29·776	1·250	54·4	32·9	21·5	47·6	39·7	7·9	43·9	38·7	·235	2·7	0·8	82	547	—	—	1·4	9	6	3	13	5·6	7·6	19	4·84
EASTBOURNE, Miss W. L. Hall.	12	July	29·865	1·021	79·5	45·7	33·8	71·6	54·6	17·0	61·9	59·2	·506	5·6	0·6	91	539	122·6	42·2	0·2	1	2	9	19	1·4	—	16	2·37
		Aug.	—	—	88·1	47·4	40·7	75·2	54·9	20·3	64·5	58·4	·492	5·8	1·8	82	—	120·8	50·8	0·3	4	4	12	11	1·0	—	6	1·74
		Sept.	29·950	1·078	78·6	42·9	35·7	67·9	55·3	12·6	60·4	55·9	·447	5·0	0·9	86	552	110·9	48·6	0·3	5	8	6	11	1·1	—	16	4·86
OSBORNE (Isle of Wight), J. R. Mann, Esq.	172	Oct.	29·910	1·320	67·1	34·2	32·9	58·1	44·0	14·1	50·2	47·7	·332	3·8	0·4	91	543	96·6	42·4	0·2	6	5	6	14	—	5·5	13	1·01
		Nov.	29·985	0·864	63·0	26·1	36·9	48·8	38·8	10·0	43·4	40·0	·247	2·8	0·4	87	552	70·5	37·8	0·1	10	6	7	7	—	6·5	12	0·96
		Dec.	29·697	1·250	54·2	27·6	26·6	45·6	37·1	8·5	41·7	39·0	·239	2·3	0·3	91	549	54·7	36·4	0·3	7	4	7	13	—	7·4	16	3·88
BRIGHTON, F. E. Sawyer, Esq., F.S.A., F. R. Met. Soc.	206	Oct.	29·870	1·088	63·0	34·0	29·0	55·7	44·2	11·5	49·3	44·9	·290	3·4	0·6	86	544	—	39·1	1·1	11	4	4	12	—	6·0	15	1·32
		Nov.	30·104	0·763	61·5	26·0	35·5	47·2	38·3	8·9	42·4	39·7	·234	2·7	0·4	87	556	—	35·1	1·0	13	5	5	8	—	6·3	12	1·76
		Dec.	29·667	1·425	53·0	30·0	23·0	44·9	36·5	8·4	41·3	37·2	·228	2·6	0·4	86	549	—	32·0	1·6	8	4	5	14	—	6·8	20	3·36
SOUTHBOURNE, (near) Bournemouth (Hants), T. A. Compton, Esq., M.D., B.A., F. R. Met. Soc.	95	Oct.	29·983	1·238	65·3	33·5	31·8	57·7	43·1	14·6	50·3	44·4	·293	3·4	0·8	80	514	—	—	1·3	13	5	3	10	—	4·9	11	1·32
		Nov.	30·028	1·150	60·4	24·4	36·0	48·8	37·9	10·9	43·5	39·1	·239	2·8	0·5	85	558	—	—	1·0	12	6	6	6	—	6·5	10	0·74
		Dec.	29·806	0·926	53·5	30·9	22·6	46·5	37·9	8·6	42·5	37·0	·221	2·5	0·5	82	551	—	—	1·9	8	4	7	12	—	6·8	16	3·63
SALISBURY (Wilton House), Wilts, Thomas Challis, Esq.	186	Oct.	29·873	1·250	67·0	26·0	41·0	59·3	37·1	22·2	48·1	43·5	·282	3·8	0·5	85	545	89·7	—	1·2	10	8	3	10	—	6·5	17	0·82
		Nov.	29·945	0·834	62·0	18·0	44·0	48·6	32·4	16·2	41·8	37·0	·221	2·6	0·5	85	554	64·5	—	1·2	14	4	8	4	—	6·7	17	1·91
		Dec.	29·669	0·970	57·0	23·0	34·0	45·8	33·6	12·2	40·4	33·4	·190	2·3	0·7	76	550	56·6	—	1·4	10	4	5	12	—	6·9	19	3·27

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean. Of all Highest.	Temperature of Air in Month. Mean. Of all Lowest.	Temperature of Air in Month. Mean. Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a Cubic foot of Air. Mean.	Vapour. In a Cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	Wind. E.	Wind. S.	Wind. W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
BARNSTAPLE (Devon). William Knill, Esq.	43	Oct.	30.069	1.370	64.0	35.0	29.0	58.4	47.8	10.6	52.2	49.4	.352	4.0	0.3	94	545	—	—	1.4	6	4	6	15	—	4.9	20	3.98
		Nov.	30.147	0.840	61.0	29.0	32.0	51.5	41.1	10.4	46.2	41.5	.263	3.0	0.6	84	552	—	—	1.0	10	6	6	8	—	4.5	20	2.96
		Dec.	29.875	0.910	56.0	32.0	24.0	48.3	40.2	8.1	44.5	39.2	.240	2.8	0.6	82	549	—	—	1.4	8	4	10	9	—	5.4	20	4.97
BATH (Somerset), St. Gregory's College, Downside, Rev. T. J. Almond, O.S.B.	596	Oct.	29.445	1.294	63.4	33.0	29.4	54.2	42.2	12.0	47.9	43.7	.285	3.2	0.7	87	537	93.4	31.9	1.4	11	4	4	12	—	5.3	10	1.32
		Nov.	29.503	0.833	53.1	23.8	31.3	46.5	37.3	9.2	41.8	39.4	.241	2.9	0.2	92	545	69.7	26.0	1.6	9	7	5	9	—	7.2	13	2.56
		Dec.	29.228	1.010	52.9	28.9	24.0	43.7	35.4	8.3	39.8	36.6	.217	2.6	0.4	90	542	55.5	26.1	2.0	7	5	7	12	—	7.6	18	7.05
MARLBOROUGH (Wilts), Rev. Thomas A. Preston, M.A., F.R. Met. Soc.	456	Oct.	29.582	1.290	64.0	30.0	34.0	56.0	39.7	16.3	47.7	43.2	.279	3.2	0.6	86	540	92.3	34.8	0.6	8	4	6	13	—	6.7	11	1.01
		Nov.	29.645	0.772	57.2	20.5	36.7	46.1	34.5	11.6	40.2	37.7	.225	2.6	0.4	91	550	68.4	28.4	0.5	10	8	6	6	—	7.2	16	1.94
		Dec.	29.573	1.280	53.0	28.2	24.8	43.7	35.0	8.7	39.4	35.8	.211	2.4	0.4	87	545	57.2	30.8	0.9	7	6	4	13	—	7.9	19	3.11
BLACKHEATH (Kent), James Glaisher, Esq., F.R.S.	150	Oct.	29.899	1.268	62.0	35.0	27.0	55.7	42.9	12.8	49.0	43.2	.280	3.2	0.8	81	544	90.3	34.3	0.9	8	5	4	14	—	6.4	13	1.08
		Nov.	29.981	0.836	60.0	25.2	34.8	47.2	37.2	10.0	42.5	38.3	.232	2.7	0.5	86	553	73.4	29.2	0.5	6	5	6	11	—	6.5	8	1.18
		Dec.	29.702	1.366	54.5	27.5	27.0	45.0	36.7	8.3	41.1	36.6	.217	2.5	0.5	84	549	53.5	28.2	1.2	6	7	7	11	—	7.8	17	1.99
ROYAL OBSERVATORY, Greenwich, W. H. M. Christie, M.A., F.R.S., Astronomer Royal.	159	Oct.	29.865	1.277	62.7	32.1	30.6	56.5	41.6	14.9	48.9	43.7	.285	3.2	0.6	83	544	89.2	33.7	—	—	—	—	—	1.0	6.7	12	1.04
		Nov.	29.978	0.848	61.2	24.5	36.7	47.6	36.8	10.8	42.4	38.3	.231	2.7	0.5	86	553	64.4	30.9	—	—	—	—	—	1.2	6.7	12	0.99
		Dec.	29.690	1.432	55.1	26.7	28.4	45.1	36.5	8.6	41.0	37.2	.222	2.6	0.4	87	549	52.2	32.9	—	—	—	—	—	2.4	8.2	18	2.54
WHITCHURCH RECTORY (Oxon), (near Reading), Rev. J. Slatter, M.A., F.R. Met. Soc.	150	Oct.	29.849	0.938	63.0	28.8	34.2	56.0	39.1	16.9	47.4	42.5	.272	3.1	0.6	85	545	—	—	1.4	6	4	8	12	—	5.8	12	0.77
		Nov.	30.023	0.800	60.5	24.8	35.7	47.4	34.7	12.7	41.2	38.7	.235	2.7	0.3	91	559	—	—	0.6	10	9	4	7	—	5.8	11	1.27
		Dec.	29.719	1.250	53.5	25.3	28.2	44.2	34.9	9.3	40.1	36.9	.219	2.5	0.4	89	551	—	—	1.0	7	6	6	12	—	7.2	20	2.10
CAMDEN SQUARE (London), G. J. Symons, Esq., F.R.S., F. R. Met. Soc.	123	Oct.	29.937	1.288	63.9	32.2	31.7	57.1	41.9	15.2	49.5	43.8	.281	3.2	0.9	79	544	81.2	36.7	—	9	5	5	11	—	6.0	10	0.99
		Nov.	30.022	0.817	60.2	25.3	34.9	48.3	37.3	11.0	42.8	38.4	.232	2.6	0.5	85	554	60.8	31.6	—	11	10	4	5	—	6.9	12	1.92
		Dec.	29.740	1.442	55.7	23.5	37.2	45.9	36.6	9.3	41.6	37.1	.222	2.5	0.5	85	560	51.5	33.0	—	7	5	8	11	—	7.8	17	2.57
BARNET (Gas Works), T. H. Martin, Esq., C.E.	212	Oct.	29.875	1.292	64.1	25.2	38.9	56.8	39.3	17.5	47.8	44.0	.288	3.2	0.5	87	545	91.6	37.1	1.0	12	7	2	10	—	6.1	7	1.08
		Nov.	29.966	0.857	60.1	20.1	40.0	47.6	34.2	13.4	41.0	37.6	.225	2.6	0.4	88	555	68.3	31.8	0.5	10	8	5	7	—	7.1	9	1.24
		Dec.	29.665	1.343	55.1	23.0	32.1	44.2	35.3	8.9	40.8	36.2	.214	2.5	0.5	86	550	54.4	32.7	1.3	7	8	3	13	—	8.4	17	4.05
OXFORD (The Observatory), E. J. Stone, Esq., M.A., F.R.S.	210	Oct.	29.851	1.298	63.3	34.6	28.7	56.8	43.3	13.5	49.5	43.9	.288	3.3	0.8	82	543	94.5	37.1	2.7	6	3	7	15	0.8	6.7	5	0.76
		Nov.	29.925	0.879	60.1	26.2	33.9	48.5	37.4	11.1	42.5	38.3	.231	2.7	0.5	85	552	72.8	32.0	2.3	8	5	10	7	0.0	6.9	9	0.99
		Dec.	29.645	1.382	54.6	23.1	31.5	45.2	37.4	7.8	41.0	35.9	.218	2.5	0.5	86	549	60.9	33.5	3.5	6	5	9	11	1.5	7.5	19	2.67
ROYSTON (Hertfordshire), Hale Wortham, Esq., F.R.A.S., F. R. Met. Soc.	269	Oct.	29.781	1.278	64.6	33.2	31.4	56.0	41.3	14.7	47.7	41.4	.261	3.2	0.6	79	544	—	—	—	6	8	8	14	—	6.4	9	1.49
		Nov.	29.852	0.874	59.0	25.0	34.0	47.2	35.9	11.3	41.3	37.1	.221	2.6	0.5	86	553	—	—	—	7	5	9	9	—	6.8	10	1.45
		Dec.	29.504	1.289	54.7	26.1	28.6	43.2	34.8	8.4	39.1	35.8	.211	2.4	0.4	89	551	—	—	—	6	5	10	10	—	6.8	16	2.00
*BEDFORD, Cardington, Mr. J. McLaren, Assistant to S. Whitbread, Esq., M.P.	105	Oct.	29.937	1.266	67.4	27.4	40.0	58.5	40.2	18.3	48.7	45.9	.310	3.5	0.3	90	546	73.5	36.8	1.3	8	2	5	16	—	6.5	9	1.18
		Nov.	30.048	0.850	62.0	21.0	41.0	47.2	34.4	12.8	40.4	38.5	.236	2.7	0.2	95	557	52.9	30.2	0.8	10	4	9	7	—	6.2	10	1.14
		Dec.	29.731	1.398	51.6	20.2	31.4	43.8	34.5	9.3	39.2	37.5	.225	2.6	0.3	94	552	45.0	31.2	1.7	7	4	4	16	—	7.6	17	1.75
CAMBRIDGE (Trinity College), J. W. L. Glaisher, Esq., M.A., F.R.S.	40	Oct.	29.994	1.258	64.2	28.7	35.5	59.0	41.7	17.3	49.2	44.4	.294	3.4	0.6	84	546	95.7	34.3	1.3	5	4	5	17	—	6.0	8	1.13
		Nov.	30.103	0.888	60.7	22.4	38.3	47.1	35.8	11.3	41.4	38.2	.241	2.7	0.4	89	557	68.2	29.1	1.1	7	5	9	9	—	6.2	13	1.12
		Dec.	29.785	1.318	55.8	22.0	33.8	43.9	35.5	8.4	40.1	37.1	.221	2.5	0.3	89	552	55.5	30.0	1.7	6	6	6	13	—	8.2	18	1.81
RUGBY (Warwickshire), Stockton, The Rectory, Rev. W. Tuckwell.	289	Oct.	29.700	1.193	64.0	28.8	35.2	56.4	39.5	16.9	47.0	43.4	.282	3.3	0.4	88	543	—	—	0.6	5	4	4	18	—	6.7	7	1.38
		Nov.	29.792	0.786	58.8	18.5	40.3	47.8	33.5	14.3	40.7	38.7	.235	2.6	0.2	82	552	—	—	0.3	5	7	10	8	—	7.6	10	1.38
		Dec.	29.469	1.076	53.8	21.8	32.0	44.0	33.4	10.6	39.1	36.1	.218	2.4	0.4	89	548	—	—	0.6	7	6	10	8	—	8.0	14	2.00
LOWESTOFT (Suffolk), S. H. Miller, Esq., F.R.A.S., F. R. Met. Soc.	89	Oct.	29.908	1.380	62.5	34.0	28.5	55.9	43.6	12.3	49.5	48.9	.288	3.2	0.8	82	544	92.2	38.8	2.2	7	3	4	17	—	7.1	13	3.32
		Nov.	30.022	0.916	58.8	24.0	34.8	47.6	38.2	9.4	43.0	39.0	.238	2.8	0.4	86	553	71.6	33.8	2.2	7	4	6	13	—	7.1	19	1.80
		Dec.	29.720	1.616	54.5	[illegible]	[illegible]	44.8	36.5	8.3	41.0	38.2	.230	2.7	0.2	94	551	57.7	32.2	3.1	5	6	7	13	—	7.2	18	2.50

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean	Pressure of Atmosphere in Month. Range	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean Of all Highest.	Temperature of Air in Month. Mean Of all Lowest.	Temperature of Air in Month. Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Sat^{n}. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	Wind. Relative Proportion of E.	Wind. Relative Proportion of S.	Wind. Relative Proportion of W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs	°	°									in.
SOMERLEYTON (Suffolk), The Rectory, Rev. C. J. Steward, F. R. Met. Soc.	50	Oct.	29·963	1·310	63·0	30·0	33·0	56·2	42·9	13·3	48·9	43·9	·288	3·3	0·7	83	544	—	—	1·1	6	3	7	15	5·6	6·1	11	3·98
		Nov.	30·090	0·878	59·0	21·8	36·2	47·3	37·7	9·6	41·9	39·4	·244	2·8	0·3	92	571	—	—	1·0	7	5	9	9	6·7	7·1	17	2·10
		Dec.	29·761	1·596	55·2	26·0	29·2	45·5	36·5	9·0	40·8	38·1	·230	2·6	0·3	91	551	—	—	1·1	5	6	9	11	6·3	7·5	17	2·21
WOLVERHAMPTON (Staffordshire), Wrottesley, E. Simpson, Esq.	500	Oct.	29·547	1·250	61·9	28·5	33·4	53·7	39·7	14·0	46·1	41·3	·260	2·6	0·6	84	541	—	—	—	8	3	8	12	—	7·1	10	1·46
		Nov.	29·629	0·830	57·8	22·0	35·8	46·6	33·6	13·0	40·1	37·1	·221	2·5	0·6	89	550	—	—	—	5	6	11	8	—	8·1	12	1·43
		Dec.	29·320	1·202	53·8	24·9	28·9	42·6	32·2	10·4	37·9	33·6	·193	2·2	0·4	85	546	—	—	—	5	6	11	9	—	8·4	16	2·15
LEICESTER (Town Museum), J. C. Smith, Esq.	238	Oct.	29·776	1·294	64·7	31·5	33·2	56·0	41·4	14·6	48·5	42·2	·270	3·1	0·7	89	543	85·6	34·2	0·8	6	1	8	16	—	6·3	13	1·52
		Nov.	29·879	0·858	59·5	23·5	36·0	47·2	34·4	12·8	41·4	36·4	·216	2·5	0·5	85	553	62·5	29·4	1·1	8	6	9	7	—	6·5	13	1·57
		Dec.	29·567	1·287	54·0	23·2	30·8	43·9	35·0	8·9	39·8	34·8	·202	2·3	0·6	83	549	51·6	28·5	0·9	6	4	9	12	—	6·5	18	2·14
NOTTINGHAM (Notts), M. O. Tarbotton, Esq., C.E., F.G.S., F. R. Met. Soc.	123	Oct.	29·907	1·326	62·4	33·9	28·5	54·8	42·6	12·2	48·2	42·1	·268	3·1	0·7	80	545	78·1	38·9	0·3	8	3	9	11	0·4	6·7	19	0·67
		Nov.	30·006	0·844	58·1	23·7	34·4	48·3	37·4	10·9	42·6	38·9	·237	2·7	0·4	87	554	57·4	34·1	0·2	5	6	12	7	0·5	5·6	19	0·83
		Dec.	29·671	1·316	54·7	26·9	27·8	44·3	36·2	8·1	40·2	36·1	·212	2·5	0·5	86	550	50·0	32·1	0·3	3	7	10	11	0·6	7·9	25	2·22
HOLKHAM (Norfolk), John Davidson, Esq., Assistant to the Earl of Leicester.	39	Oct.	29·962	1·218	60·3	31·6	28·7	54·9	39·9	15·0	47·1	44·4	·292	3·1	0·4	91	547	86·9	34·9	1·5	7	3	11	10	—	5·2	9	3·05
		Nov.	30·063	0·906	59·5	22·0	37·5	47·3	34·0	13·3	41·4	36·4	·216	2·5	0·5	84	556	63·1	28·3	1·0	7	3	10	7	—	6·7	15	1·99
		Dec.	29·729	1·386	54·3	21·3	33·0	44·2	33·0	11·2	39·4	34·4	·199	2·3	0·5	81	552	54·4	27·1	1·7	6	2	16	7	—	8·1	16	2·21
BURSLEM, J. E. Worth, Esq., C.E., F. R. Met. Soc.	556	Oct.	29·438	1·270	62·3	29·7	32·6	53·1	41·7	11·4	46·9	42·7	·274	3·1	0·6	86	538	—	37·9	1·2	8	2	7	14	—	7·0	18	2·60
		Nov.	29·521	1·000	55·2	24·4	30·8	45·1	35·6	9·5	40·4	37·2	·222	2·6	0·4	89	547	—	31·3	1·0	7	6	9	8	—	7·0	19	1·94
		Dec.	29·189	1·258	54·7	26·3	28·4	41·7	33·5	8·2	37·8	34·0	·196	2·3	0·4	86	543	—	29·1	1·3	4	6	7	14	—	6·8	21	2·76
LLANDUDNO (Carnarvonshire), James Nicol, Esq., M.D.	100	Oct.	29·939	1·200	61·8	40·2	21·6	55·2	46·7	8·5	51·0	43·4	·282	3·2	1·0	78	543	—	—	1·2	6	2	4	19	—	6·9	17	1·42
		Nov.	29·974	1·100	61·0	29·2	31·8	49·7	40·9	8·8	45·5	38·6	·235	2·8	0·7	71	550	—	—	1·0	9	3	7	11	—	6·6	17	3·23
		Dec.	29·687	1·550	55·0	27·0	28·0	46·1	37·9	8·2	42·5	36·9	·220	2·6	0·6	82	548	—	—	1·2	5	5	4	17	—	6·8	17	2·92
LIVERPOOL, The Observatory, John Hartnup, Esq., F.R.A.S.	197	Oct.	29·825	1·362	60·7	37·9	22·8	54·2	46·1	8·1	49·2	43·4	·282	3·2	0·8	80	543	—	—	1·8	6	4	6	15	—	6·6	19	1·59
		Nov.	29·909	1·015	61·5	29·4	32·1	48·2	39·6	8·6	43·1	37·8	·227	2·6	0·6	81	551	—	—	1·4	8	8	7	7	—	5·8	13	1·55
		Dec.	29·570	1·362	55·1	28·0	27·1	44·2	36·9	7·3	40·5	35·3	·206	2·4	0·4	83	548	—	—	1·8	5	7	6	13	—	6·1	19	3·05
BOLTON, Sharples (Lancashire), Rev. T. Mackereth, F.R.A.S., F. R. Met. Soc.	500	Oct.	29·488	1·330	59·6	29·5	30·1	52·9	42·0	10·9	47·0	42·1	·268	3·1	0·6	84	539	60·6	38·4	1·0	6	4	7	14	3·8	7·8	18	3·79
		Nov.	29·577	0·920	58·7	23·3	35·4	46·2	34·7	11·5	40·8	36·2	·214	2·4	0·5	86	548	51·7	31·9	0·7	9	6	7	8	2·0	6·1	14	2·35
		Dec.	29·257	1·708	52·1	25·3	26·8	42·0	33·0	9·0	37·7	33·7	·193	2·2	0·4	85	545	44·9	29·9	0·8	4	6	10	11	2·6	7·2	18	6·01
HALIFAX, Bermerside Observatory (Yorkshire), E. J. Crossley, Esq., F.R.A.S.	530	Oct.	29·476	1·393	63·5	29·0	34·5	53·2	40·1	13·1	45·9	41·8	·265	3·0	0·6	86	540	81·9	35·7	1·3	5	3	7	16	—	6·5	14	2·37
		Nov.	29·588	0·914	59·5	23·3	36·2	45·9	35·1	10·8	40·0	36·6	·217	2·5	0·4	88	549	62·7	30·6	0·9	5	7	8	10	—	7·1	13	1·59
		Dec.	29·228	1·313	51·0	22·1	28·9	40·5	33·6	6·9	37·2	33·8	·194	2·3	0·4	87	545	50·8	30·0	1·6	4	5	9	13	—	7·8	20	3·01
HULL (Yorkshire), The People's Park, Mr. E. Peak.	12	Oct.	30·013	1·278	62·0	33·0	29·0	55·3	40·9	14·4	47·2	42·3	·271	3·2	0·5	84	548	69·9	39·9	1·7	8	1	3	19	—	5·4	15	1·07
		Nov.	30·080	0·922	58·0	22·0	36·0	48·4	35·7	12·7	41·7	37·5	·225	2·5	0·4	86	556	54·5	35·1	1·1	4	4	7	15	—	6·4	13	1·08
		Dec.	29·772	1·364	55·0	28·0	27·0	43·9	34·9	9·0	39·8	35·9	·211	2·4	0·5	87	552	46·0	34·5	1·4	2	3	13	13	—	6·8	19	2·37
STONYHURST (Lancashire), Rev. S. J. Perry, F.R.S., F. R. Met. Soc., F.R.A.S.	363	Oct.	29·635	1·376	62·0	29·9	32·1	51·8	41·7	13·1	47·6	42·5	·273	3·2	0·5	83	541	87·8	38·1	—	5	3	8	20	—	8·1	16	3·97
		Nov.	29·737	1·137	60·0	21·9	38·1	47·5	33·6	13·9	40·7	36·2	·213	2·4	0·5	85	551	77·6	28·9	—	10	4	8	8	—	7·0	18	1·49
		Dec.	29·405	1·370	60·0	26·0	34·0	43·7	33·0	10·7	38·6	35·9	·196	2·2	0·5	84	547	58·3	29·7	—	5	6	8	17	—	7·7	19	6·40
BRADFORD (Yorkshire), J. McLandsborough, Esq., C.E., F.G.S.	366	Oct.	29·602	1·379	59·5	32·3	27·2	53·6	42·2	11·4	47·5	41·9	·266	3·1	0·7	82	541	63·7	—	0·5	8	4	6	13	—	7·1	17	1·50
		Nov	29·720	0·907	58·8	24·5	32·3	48·0	38·0	10·0	42·7	36·7	·218	2·5	0·6	80	544	52·2	—	0·6	12	3	8	7	—	7·7	17	1·14
		Dec.	29·372	1·350	54·0	28·9	25·1	43·2	35·5	7·7	39·3	34·5	·200	2·3	0·5	83	546	44·9	—	1·2	7	4	7	13	—	8·1	22	4·25
LEEDS (Yorkshire), The Philosophical Hall, Henry Crowther, Esq.	137	Oct.	29·857	1·392	62·0	33·0	29·0	55·7	44·3	11·4	50·0	41·6	·263	2·9	1·2	73	543	—	—	1·2	6	3	4	18	—	6·8	14	1·51
		Nov.	29·974	0·916	61·0	26·0	35·0	47·8	38·7	9·1	44·0	39·3	·240	2·8	0·4	86	552	—	—	1·1	6	5	8	11	—	6·9	14	0·70
		Dec.	29·612	1·268	54·0	27·0	27·0	42·5	35·9	6·6	39·6	35·7	·200	2·3	0·3	84	551	—	—	1·0	6	4	8	15	—	7·0	24	2·71

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Daily Range.	Mean Temperature. Air.	Dew Point.	Vapour. Elastic Force.	In a cubic foot of Air. Mean.	Short of Saturation.	Mean Degree of Humidity, Sat. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Minimum on Grass.	Wind. Estimated Strength	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
LANCASTER (Southfields). WILLIAM ROPER, Esq.	114	Oct.	29·915	1·318	62·5	28·5	34·0	54·4	42·3	12·1	47·9	44·5	·294	3·4	0·5	89	532	—	—	—	—	—	—	—	—	—	17	4·11
		Nov.	30·018	0·954	60·0	24·0	36·0	48·4	37·1	11·3	42·6	40·6	·253	3·0	0·3	93	548	—	—	—	—	—	—	—	—	—	14	1·85
		Dec.	29·716	1·206	53·0	25·5	27·5	40·3	33·0	7·3	35·3	35·9	·210	2·5	0·3	91	553	—	—	—	—	—	—	—	—	—	19	4·44
SILLOTH (Cumberland), "The Rectory," REV. F. REDFORD, M.A., F.R.A.S., F. R. Met. Soc.	28	Oct.	29·951	1·360	61·1	31·0	30·1	54·5	43·6	10·9	48·5	44·3	·292	3·3	0·5	86	546	94·5	38·5	1·7	6	4	6	15	9·1	6·7	12	2·41
		Nov.	30·082	1·835	57·2	22·6	34·6	46·6	35·5	11·1	40·7	36·8	·218	2·6	0·4	83	557	78·0	30·7	1·2	6	9	7	8	6·1	5·4	9	1·72
		Dec.	29·600	1·499	51·8	22·0	29·8	42·5	34·1	8·4	38·6	34·6	·201	2·3	0·5	85	552	60·0	19·0	1·4	5	9	6	11	8·2	6·8	17	4·33
CARLISLE, Spital (Cumberland). ISAAC CARTMEL, Esq., F. R. Met. Soc	114	Oct.	29·846	1·532	63·2	26·6	36·6	55·4	41·6	13·8	48·0	43·8	·285	3·3	0·5	86	544	75·0	38·2	1·0	8	5	2	21	2·6	7·6	12	2·00
		Nov.	29·959	1·276	59·8	19·6	40·2	47·9	33·3	14·6	40·4	36·5	·216	2·5	0·6	87	555	58·7	29·7	0·7	7	6	3	14	2·2	8·1	9	0·76
		Dec.	29·606	1·466	54·3	18·7	35·6	42·8	32·1	10·7	37·9	33·9	·195	2·3	0·4	86	552	43·7	28·2	1·0	3	6	6	16	3·4	8·4	17	3·34

Second Rain-gauges are placed—

Place	Height (feet)		July.	August.	September.	October.	November.	December.	Total in Quarter.
At Eastbourne, at the height of	160	feet *above the sea*; the amount collected was	1·98 inches.	1·93 inches.	4·77 inches.	inches.	inches.	inches.	inches.
„ Beachy Head	515	„ „ „	2·22 „	2·15 „	3·83 „	„	„	„	„
„ „	495	„ „ „	— „	2·16 „	3·80 „	„	„	„	„
„ Oxford	22	„ *ground* „	2·16 „	0·94 „	1·84 „	0·83 „	1·07 „	2·71 „	4·61 „
„ Cardington	21	„ „ „	2·95 „	1·20 „	1·40 „	1·26 „	1·18 „	1·58 „	4 02 „
„ Nottingham	39	„ „ „	4·11 „	0·64 „	— „	0·67 „	0·76 „	1·97 „	3·40 „
„ Holkham	4	„ „ „	2·79 „	1·32 „	2·32 „	2·19 „	1·99 „	2·21 „	7·19 „

Fog prevailed in October, on the 2nd at Barnet; on the 4th at Oxford; on the 5th at Bath, Whitchurch, Rugby, Wolverhampton; on the 7th at Bath; on the 8th at Totnes, Bath, Whitchurch, Oxford, Royston, Cardington, Cambridge, Rugby, Wolverhampton; on the 18th and 19th at Totnes; on the 21st at Totnes, Oxford, and Somerleyton; on the 22nd at Totnes, Wolverhampton; on the 23rd at Totnes, Bath, Whitchurch, Barnet, Oxford, Cardington, Cambridge, Rugby, Wolverhampton; on the 24th at Totnes, Barnet, Oxford, Cardington, Cambridge; on the 25th at Totnes, Whitchurch, Barnet, Cambridge, Rugby, Lowestoft, Somerleyton, Wolverhampton; and on the 28th at Wolverhampton.

In November, on the 1st at Cardington; on the 3rd at Bolton; on the 4th at Marlborough, Barnet, Oxford, Rugby, Somerleyton, Wolverhampton; on the 5th at Bolton; on the 6th at Torquay, Barnet, Oxford, Bolton; on the 8th at Whitchurch, Oxford; on the 10th at Cardington, Rugby, Wolverhampton, Nottingham, Bolton, and Bradford; on the 11th at Totnes, Oxford, Bradford; on the 12th at Oxford; on the 13th at Torquay, Oxford, Cardington, Rugby, Wolverhampton; on the 16th, 22nd, and 23rd, at Oxford; on the 24th at Oxford, Somerleyton, and Bolton; on the 25th at Oxford, Somerleyton, and Bolton; on the 26th at Whitchurch, Oxford, Rugby, Somerleyton, Nottingham, and Bolton; on the 29th at Oxford; and on the 30th at Marlborough, Whitchurch, Barnet, Oxford, Cardington, Rugby, and Lowestoft.

In December, on the 1st at Whitchurch and Wolverhampton; on the 2nd at Whitchurch, Cambridge, Lowestoft; on the 9th at Blackheath; on the 12th at Blackheath; on the 16th at Oxford and Somerleyton; on the 20th at Oxford; on the 26th, 27th, and 29th at Bolton; and on the 30th at Bolton; and on the 31st at Whitchurch, Cambridge, Hull, and Bradford.

NAMES OF STATIONS.	Mean Pressure of dry Air reduced to the level of the Sea.	Highest Reading of the Thermometer.	Lowest Reading of the Thermometer.	Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Wind. Mean Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days on which it fell.	Rain. Amount collected.
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
Guernsey - - -	29·832	61·8	31·9	29·9	51·7	44·2	23·2	7·6	47·8	41·1	·260	3·0	0·9	77	544	79·3	38·7	1·0	9	6	4	11	1·9	7·0	63	11·59
Truro - - -	29·700	65·0	28·0	37·0	53·3	41·7	31·8	11·6	47·1	43·3	·282	3·1	0·6	87	547	–	–	2·3	8	6	4	13	–	7·4	57	8·84
Plymouth - - -	29·816	62·5	29·8	32·7	51·5	41·3	27·0	10·3	[illegible]	43·6	·274	3·1	0·5	87	550	–	–	1·7	8	7	6	10	–	7·4	55	6·82
Totnes - - -	29·865	61·8	23·9	40·9	52·1	39·0	32·9	13·1	45·8	42·0	·268	3·1	0·4	91	549	–	–	2·5	9	4	7	11	–	7·1	49	9·43
Torquay - - -	29·809	63·6	26·5	37·1	51·1	41·6	27·4	9·5	46·1	41·3	·262	3·0	0·6	84	544	81·4	34·1	1·6	7	5	7	12	4·1	7·3	47	[illegible]
Ventnor - - -	29·768	64·2	29·5	34·7	52·4	43·1	[illegible]	[illegible]	46·4	40·8	·257	2·9	0·8	81	543	–	–	1·4	10	6	4	11	5·0	6·4	38	6·63
Osborne - - -	29·782	67·1	26·1	41·0	50·8	39·9	32·1	10·9	45·1	42·2	·273	3·1	0·4	90	538	70·6	33·7	[illegible]	8	5	7	11	–	6·5	41	5·85
Brighton - - -	29·851	63·0	26·0	37·0	49·3	39·7	[illegible]	9·6	44·3	40·6	·252	2·9	0·5	86	[illegible]	–	35·4	1·2	11	4	5	11	–	6·4	47	5·94
Southbourne - -	29·793	65·3	24·4	40·9	51·0	39·6	[illegible]	11·4	45·4	40·2	·251	2·9	0·6	82	549	–	–	1·4	11	5	5	9	–	5·9	37	5·69
Salisbury - - -	29·807	67·0	18·0	49·0	51·2	34·4	39·7	16·9	43·3	38·0	·231	2·7	0·6	83	550	70·3	–	1·3	11	5	5	9	–	7·0	53	6·00
Barnstaple - - -	29·799	64·0	29·0	35·0	52·7	43·0	[illegible]	9·7	47·6	43·4	·285	3·3	0·5	87	549	–	–	1·3	8	5	8	10	–	4·9	60	11·93
Bath - - -	29·794	62·4	23·8	38·6	48·1	38·3	[illegible]	9·8	[illegible]	39·9	·248	2·9	0·4	90	541	74·5	25·0	1·7	9	5	5	11	–	6·7	41	10·93
Marlborough - -	29·791	64·0	20·5	43·5	48·6	36·4	[illegible]	12·2	42·4	38·9	·238	2·7	0·5	84	545	72·6	31·3	0·7	8	6	5	11	–	7·3	46	6·06
Blackheath - -	29·785	62·0	25·2	36·8	49·3	38·9	29·6	10·4	44·2	39·4	·243	2·8	0·6	84	549	72·4	30·6	0·9	7	6	6	12	–	6·9	38	4·25
Royal Observatory -	29·782	62·7	24·5	38·2	49·7	38·8	31·9	11·4	44·1	39·7	·243	2·8	0·5	85	549	69·3	33·5	–	·	·	·	·	1·2	7·2	42	4·57
Whitchurch -	29·787	63·0	24·8	38·2	49·2	36·2	32·7	13·0	42·9	39·4	·242	2·8	0·4	88	552	–	–	[illegible]	8	6	6	10	–	6·3	43	4·14
Camden Square -	29·789	63·9	25·8	38·6	50·5	38·6	[illegible]	11·8	44·6	39·6	·245	2·8	0·6	83	549	61·5	33·8	–	9	7	6	9	–	6·7	39	5·48
Barnet - - -	29·826	64·1	20·1	44·0	49·5	36·3	[illegible]	13·3	43·0	39·3	·242	2·8	0·5	87	550	71·4	33·5	[illegible]	10	8	3	10	–	7·2	33	6·32
Oxford - - -	29·793	63·3	23·1	40·2	50·2	39·4	[illegible]	10·8	44·3	39·7	·246	2·8	0·6	84	548	[illegible]	34·2	[illegible]	7	4	9	11	0·8	7·0	33	4·42
Royston - - -	29·814	64·6	25·0	39·6	48·8	37·8	[illegible]	11·5	42·7	38·1	·231	2·7	0·5	85	549	–	–	–	6	4	9	11	–	6·7	35	4·94
Cardington - -	29·770	67·4	20·2	47·2	49·8	36·4	38·5	13·5	42·8	40·7	·257	2·9	0·3	93	552	57·1	32·7	1·3	8	8	6	13	–	6·8	36	4·07
Cambridge - -	29·756	64·2	24·0	42·2	40·0	37·7	35·9	[illegible]	43·6	39·9	·249	2·9	0·4	87	552	73·2	31·1	1·4	6	5	7	13	–	6·8	39	4·06
Rugby - - -	29·730	64·0	18·5	45·5	49·4	35·5	35·8	13·9	42·8	39·4	·240	2·8	0·3	86	548	–	–	0·5	6	6	8	11	–	7·4	31	4·76
Lowestoft - -	29·729	62·5	24·0	38·5	49·4	39·4	[illegible]	10·0	44·5	40·4	·252	2·9	0·5	87	549	73·6	34·8	2·5	6	4	6	14	–	7·1	50	7·62
Somerleyton - -	29·740	63·0	23·8	40·2	49·7	39·0	32·8	10·6	43·9	40·5	·254	2·9	0·4	89	552	–	–	1·1	6	5	8	12	6·2	6·9	45	6·29
Wolverhampton -	29·819	61·9	22·0	39·9	47·6	35·2	32·7	12·5	41·4	37·3	·225	2·4	0·5	86	546	–	–	–	6	5	10	10	–	7·0	33	5·04
Leicester - - -	29·774	64·7	23·2	41·5	49·0	36·9	33·3	12·	43·2	37·8	·229	2·6	0·6	86	548	66·6	30·7	0·9	7	4	9	12	–	6·4	41	5·21
Nottingham -	[illegible]	62·4	23·7	38·7	49·1	38·7	30·	10·4	41·7	39·0	·239	2·8	0·5	84	550	61·8	35·0	0·3	5	5	10	10	0·5	6·7	63	3·72
Burslem - - -	[illegible]	62·8	24·4	37·9	46·6	36·9	[illegible]	9·7	41·7	38·0	·231	2·7	0·5	87	543	–	42·3	1·2	6	5	8	12	–	6·9	58	6·70
Holkham - - -	[illegible]	60·3	21·3	39·0	48·8	35·6	38·1	13·2	42·6	38·4	·236	2·6	0·5	86	552	68·1	30·1	1·4	7	3	13	8	–	6·7	40	7·25
Llandudno - - -	29·726	61·8	27·0	34·8	50·3	41·8	[illegible]	8·5	46·3	39·6	·246	2·9	0·8	77	547	–	–	[illegible]	7	3	5	16	–	6·8	51	7·57
Liverpool - - -	29·745	61·5	28·0	33·5	48·9	40·9	27·	8·0	44·3	38·8	·238	2·7	0·6	81	547	–	–	1·7	6	6	6	12	–	6·2	51	6·19
Bolton - - -	29·761	59·6	23·3	36·3	47·0	36·6	[illegible]	10·5	41·7	37·3	·223	2·6	0·5	85	544	53·4	31·4	0·8	6	5	8	11	2·8	7·0	50	12·15
Halifax - - -	29·751	63·5	22·1	41·4	46·5	36·3	[illegible]	10·3	41·0	37·4	·225	2·6	0·5	87	545	65·1	[illegible]	1·5	5	5	8	13	–	7·1	47	8·77
Hull - - -	29·782	62·0	22·0	40·0	49·2	37·2	30·7	12·0	42·9	38·6	·236	2·7	0·5	86	552	56·8	36·5	1·4	5	2	8	16	–	6·2	47	4·52
Stonyhurst - -	29·760	62·0	21·9	40·1	48·7	36·1	34·7	12·6	[illegible]	37·5	·227	2·6	0·5	84	546	74·6	[illegible]	–	7	4	5	15	–	7·6	48	11·86
Bradford - - -	29·735	59·5	26·5	33·0	48·3	38·6	28·2	9·7	43·2	37·7	·228	2·6	0·6	82	545	53·6	–	0·8	9	4	7	11	–	7·6	56	6·89
Leeds - - -	29·727	62·0	26·0	34·0	48·7	39·6	[illegible]	9·0	44·2	38·9	·237	2·7	0·6	82	549	–	–	1·1	6	4	7	14	–	6·9	51	4·92
Lancaster - - -	29·753	62·5	24·0	38·5	47·7	37·5	22·5	10·2	42·9	40·8	·252	3·0	0·4	91	546	–	–	–	–	–	–	–	–	–	50	10·41
Silloth - - -	29·695	61·1	22·0	39·1	47·9	37·7	31·5	10·1	42·6	38·6	·237	2·7	0·5	86	552	77·5	32·7	1·4	6	7	8	11	7·8	6·1	38	8·46
Carlisle - - -	29·696	63·2	18·7	44·5	48·7	35·7	37·5	13·0	42·1	38·1	·232	2·7	0·5	86	550	61·1	32·0	0·9	4	6	4	17	2·7	8·0	58	6·10

The highest temperatures of the air were at Cardington, 67°·4; at Osborne, 67°·1; and at Salisbury, 67°·0.
The lowest temperatures of the air were at Salisbury, 18°·0; at Rugby, 18°·5; and at Carlisle, 18°·7.
The greatest ranges of temperature were at Salisbury, 16°·9; at Rugby, 13°·9; and at Cardington, 13°·5.
The least ranges of temperature were at Guernsey, 7°·6; at Liverpool, 8°·0; and at Llandudno, 8°·5.
The greatest number of days of rain were at Guernsey and Nottingham, 63; at Burslem, 58; and at Truro, 57.
The least number of days of rain were at Rugby, 31; at Barnet and Oxford, 33; at Royston, 35.
The greatest falls of rain were at Bolton, 12·15 inches; at Barnstaple, 11·93 inches; at Stonyhurst, 11·86 inches.
The least falls of rain were at Nottingham, 3·72 inches; at Cambridge, 4·06 inches; at Cardington, 4·07 inches.

QUARTERLY METEOROLOGICAL TABLE for different PARALLELS of LATITUDE.

PARALLELS OF LATITUDE, &c.	Mean Pressure of dry Air reduced to the level of the Sea.	Mean of all Highest Readings of the Thermometer.	Mean of all Lowest Readings of the Thermometer.	Mean Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Wind. Mean Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Mean Number of Days it fell.	Rain. Mean Amount collected.
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
Guernsey - - - - -	29·822	61·8	31·9	29·9	51·7	44·2	23·2	7·6	47·8	41·1	·260	3·0	0·9	77	544	79·3	38·7	1·0	9	6	4	11	1·9	7·0	63	11·59
Between the Latitudes 50° and 51° -	29·792	64·4	26·8	37·6	51·4	40·7	29·6	10·6	45·8	40·4	·252	2·9	0·6	86	547	76·0	36·1	1·5	9	5	6	11	4·6	6·8	46	6·12
51° and 52° -	29·792	63·6	23·4	40·2	49·8	38·0	32·2	11·9	44·0	39·7	·247	2·8	0·5	86	548	71·4	32·0	1·3	9	6	6	10	1·5	6·7	43	6·41
52° and 53° -	29·769	63·6	22·5	41·0	48·9	37·2	33·4	11·8	42·9	39·0	·240	2·8	0·5	87	549	66·8	32·5	1·1	6	4	9	11	3·3	6·9	44	5·61
53° and 54° -	29·747	61·6	24·5	37·1	48·4	38·3	29·4	10·1	43·2	38·5	·235	2·7	0·6	84	547	60·6	33·5	1·2	6	4	7	14	–	6·9	50	8·14
54° and 55° -	29·696	62·1	20·3	41·8	48·3	36·7	34·5	11·6	42·4	38·4	·235	2·7	0·5	86	551	69·3	32·4	0·8	5	6	5	15	5·3	7·0	58	7·28
Mean for the Quarter, 50° to 55° Year 1881	29·685	63·4	23·6	39·9	50·0	38·9	32·9	11·1	44·5	40·3	·255	2·9	0·5	86	547	72·3	33·5	1·4	4	7	9	11	3·7	6·4	50	9·96
" 1882	29·458	68·1	18·8	49·3	49·3	38·7	36·3	10·6	43·9	40·4	·256	2·9	0·4	88	545	70·5	34·2	1·3	6	7	7	11	4·3	7·2	65	15·05
" 1883	29·696	63·1	24·6	38·5	50·1	39·0	29·7	11·1	44·4	40·6	·255	2·9	0·4	87	545	70·5	35·0	1·8	6	4	7	14	4·1	6·8	54	9·00
" 1884	29·757	63·1	23·6	39·5	49·5	38·3	31·8	11·2	43·7	39·2	·245	2·8	0·5	86	548	68·8	33·4	1·2	7	5	7	12	3·7	6·9	45	6·28

METEOROLOGY OF ENGLAND,

DURING THE QUARTER ENDING MARCH 31, 1885.

REMARKS ON THE WEATHER DURING THE QUARTER ENDING MARCH 31ST, 1885.

By JAMES GLAISHER, ESQ., F.R.S., *&c.*

The weather in January was dull with very little sunshine; the temperature was variable till the 11th, it then was cold from the 12th to the 26th, and then warm to the end of the month. The atmospheric pressure was above its average till the 7th, and again between the 15th and 26th days, and below at other times. The fall of rain was below the average. There was a marked excess of the E. and deficiency of S.W. winds. Snow fell on 11 different days at different parts of the country. It was a seasonable month of winter weather.

The weather in February was unsettled, with frequent heavy falls of rain. The temperature was above its average on every day excepting from the 18th to the 22nd, which were slightly below. The atmosphere pressure was generally below its average, excepting from the 10th to the 13th days. The fall of rain was above the average. The S.W. and W. winds were slightly in excess of their average. There were a few bright, warm days, but the sky was generally cloudy. The month was seasonable.

The weather in March was dry and cold, with frequent frost at night. The temperature with the exception of three or four days, scattered over the month, was below the average. The atmospheric pressure was generally below the average till the 9th, and from the 18th to the 22nd, and above on other days. The fall of rain was less than the average at nearly all the stations, and there was an excess of E. and compounds with the E. winds. The month was favourable for agricultural purposes, but vegetation at the end of the month was backward. It was the coldest March since 1875, excepting that in 1883, when the mean temperature of this month was 36°·1.

About London the mean daily temperature of the air was below its average, with few exceptions at the beginning of the month, till January 26th, the deficiency being 2°·4 daily; for the next 22 days, viz., till February 17th, the temperature was in excess of the average by 6°·0 daily. From February 18th till the 22nd the mean deficiency was 2°·7, for the last six days in February the mean daily excess equalled 7°·0; and from March 1st to the end of the quarter there was a slight deficiency of mean temperature averaging 2°·1 daily.

The mean temperature of the air for January was 36°·6, being 0°·1 above the average of 114 years and 1°·9 below the average of 44 years; it was 7°·3, 4°·6, and 3°·8 lower than in 1884, 1883, and 1882 respectively.

The mean temperature of the air for February was 43°·9, being 5°·2 and 4°·3 above the averages of 114 years and 44 years respectively; it was 2°·0, 1°·3, and 2°·1 higher than in 1884, 1883, and 1882 respectively.

The mean temperature of the air for March was 40°·3, being 0°·8 and 1°·4 below the averages of 114 years and 44 years respectively; it was 4°·2, lower than in 1884, 4°·2 higher than in 1883, and 5°·7 lower than in 1882.

The mean temperature of the quarter was 40°·3, being 1°·5 and 0·°3 above the averages of 114 years and 44 years respectively.

The mean high day temperature of the air in January was 40°·2, being 2°·8 below the average of 44 years; in February it was 49°·4, being 3°·8 above the average of 44 years; and in March it was 49°·0, being 1°·0 below the average of 44 years.

The mean low night temperature of the air in January was 32°·3, being 1°·4 below the average of 44 years; in February it was 38°·6, being 4°·1 above the average of 44 years, and in March it was 32°·5, being 2°·7 below the average of 44 years.

The mean daily range of temperature in January was 7°·9, being 1°·7 smaller than the average; in February it was 10°·8, being 0°·3 smaller than the average, and in March it was 16°·5, being 1·8 greater than the average.

The mean temperature of the air for January was 4°·4 lower than in December, in February it was 7°·3 higher than in January, and in March it was 3°·6 lower than in February.

(From the preceding 44 years' observations the decrease of temperature from December to January is 1°·4, the increase from January to February is 1°·2, and the increase from February to March is 2°·0.)

From December to January there was a decrease of temperature at stations south of 51° of 3°·9, between 51° and 52° of 4°·1, between 52° and 53° of 3°·4, between 53° and 54° of 2°·2, and north of 54° of 0°·9.

From January to February there was an increase of temperature at stations south of 51° of 6°·0, between 51° and 52° of 6°·7, between 52° and 53° of 5°·9, between 53° and 54° of 4°·2, and north of 54° of 3°·3.

From February to March there was a decrease of temperature at stations south of 51° of 2°·9, between 51° and 52° of 3°·4, between 52° and 53° of 2°·5, between 53° and 54° of 2°·0, and north of 54° of 1°·4.

The mean reading of the barometer for the month of January was 29·713 ins., being 0·043 in. below the average of 44 years, and being 0·202 in., 0·022 in., and 0·472 in. lower than in 1884, 1883, and in 1882, respectively.

The mean reading of the barometer for the month of February was 29·543 ins., being 0·248 in., below the average of 44 years, and 0·201 in., 0·361 in., and 0·508 in. lower than in 1884, 1883 and 1882 respectively.

A

1885. Months.	Temperature of Air. Mean.	Air. Diff. from average of 114 years.	Air. Diff. from average of 44 years.	Evaporation. Mean.	Evaporation. Diff. from average of 44 years.	Dew Point. Mean.	Dew Point. Diff. from average of 44 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 44 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 44 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 44 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	grs.
Jan. -	36·6	+0·1	−1·9	35·3	−1·7	33·4	−1·6	7·9	−1·7	0·191	−0·010	2·3	−0·1
Feb. -	43·9	+5·2	+4·3	42·1	+4·2	40·1	+4·7	10·8	−0·3	0·248	+0·039	2·9	+0·5
Mar. -	40·3	−0·8	−1·4	37·4	−1·9	33·8	−2·3	16·5	+1·8	0·194	−0·024	2·3	−0·2
Means -	40·3	+1·5	+0·3	38·3	+0·2	35·8	+0·3	11·7	−0·1	0·211	+0·002	2·5	+0·1

1885. Months.	Degree of Humidity. Mean.	Humidity. Diff. from average of 44 years.	Reading of Barometer. Mean.	Barometer. Diff. from average of 44 years.	Weight of a Cubic Foot of Air. Mean.	Weight. Diff. from average of 44 years.	Rain. Amount.	Rain. Diff. from average of 70 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
Jan. -	88	+ 1	29·713	−0·043	555	+ 1	1·42	−0·46	324	16	13	2	16·9	46·2
Feb. -	86	+ 1	29·543	−0·248	543	.−10	2·34	+0·75	361	6	17	5	22·7	47·5
Mar. -	78	− 3	29·900	+0·151	554	+ 4	1·50	−0·03	274	24	7	0	20·5	37·4
Means -	83	0	29·719	−0·047	551	− 2	Sum 5·26	Sum +0·26	Mean 320	Sum 46	Sum 37	Sum 7	Lowest 16·9	Highest 47·5

NOTE.—In reading this table it will be borne in mind that the sign (+) signifies *above* the average, and the minus sign (−) signifies *below* the average.

Average duration of the different directions of the wind referred to eight points of the compass, and duration of each direction in each month in the quarter, were as follows:—

Direction of Wind.	January. 1885.	January. Average.	January. Departure from Average.	February. 1885.	February. Average.	February. Departure from Average.	March. 1885.	March. Average.	March. Departure from Average.
	d.	d.	d.	d.	d.	d.	d.	d.	d.
N.W.	0	1½	− 1½	3¼	2	+1¼	6¾	2¾	+4
N.	2¾	3¾	− 1	¾	3	−2¼	1	3¾	−2¾
N.E.	2¾	3¾	− 1	½	3½	−3	7½	4	+3½
E.	11½	¾	+10¾	2	2	.0	6	2½	+3½
S.E.	1¾	2¼	− ½	2¾	1½	+1¼	2¾	2	+ ¾
S.	6	4¼	+ 1¾	2¼	3	− ¾	¼	2¼	−2¼
S.W.	4	9¾	− 5¾	11½	8	+3½	6	7¾	−1¾
W.	1½	3½	− 2	5¼	2¾	+2½	¾	3¼	−2½
Calm.	0	2¼	− 2¼	0	2½	−2½	0	2½	−2½

The plus sign (+) denotes excesses over averages; the largest numbers affected with this sign in the month of January are opposite to E. and S.; in February to S.W. and W.; in March to E. and N.E.

The minus sign (−) denotes deficiencies below averages. In January the largest numbers are opposite to S.W. and W.; in February to N.E. and W.; and in March to N. and S.

The mean reading of the barometer for the month of March was 29·900 ins., being 0·151 in. above the average of 44 years, and 0·138 ins., 0·151 in., and 0·057 in. higher than 1884, 1883, and 1882, respectively

From December to January there was a decrease at stations south of 51° of 0·028 in., between 51° and 52° of 0·001 in., between 52° and 53°, an increase of 0·051 in., between 53° and 54° of 0·038 in., and north of 54° of 0·075 in.

From January to February there was a decrease at stations south of 41° of 0·167 in., between 51° and 52° of 0·175 in., between 52° and 53° of 0·216 in., between 53° and 54° of 0·240 in., and north of 54° of 0·298 in.

From February to March there was an increase at stations south of 51° of 0·357 in. between 51° and 52° of 0·373 in., between 52° and 53° of 0·409 in., between 53° and 54° of 0·460 in., and north of 54° of 0·524 in.

About London the barometric pressure was for the first week in January in excess of its average by 0·25 in. daily; the deficiency for the second week was 0·32 in. daily; from the 15th to the 26th the pressure was slightly in excess of the average values by 0·16 in.; from January 27th, to February 9th, the pressure was below, the deficiency being 0·45 in., January 30th, January

31st, February 1st, 2nd, 3rd, 4th, and 5th, being as much as 0·66 in., 0·79 in., 0·59 in., 0·78 in., 0·65 in., 0·59 in., and 0·54 in. respectively below their averages, for 4 days a daily excess of 0·08 in. For the next 24 days, viz., till March 9th, the pressure was generally below its average, the mean daily deficiency being 0·24 in.; from March 10th to the 17th the mean excess was 0·35 in. daily, for 5 days a daily deficiency averaging 0·14 in., and from March 23rd to the end of the quarter there was an excess of atmospheric pressure to the amount of 0·24 in.

Thunderstorms occurred in January on the 10th at Nottingham; on the 11th at Truro; and on the 31st at Guernsey, Plymouth, Totnes, Torquay, and Salisbury.

In February on the 18th at Bolton; and on the 27th at Stonyhurst.

Thunder was heard but lightning was not seen in January, on the 31st at Ventnor.

In February on the 1st at Stonyhurst; on the 27th at Rugby, Leicester, and Halifax; and on the 28th at Cardington.

Lightning was seen but thunder was not heard in January, on the 10th at Guernsey; and on the 31st at Torquay, Southbourne, Bath, Whitchurch, Oxford, Cardington, and Cambridge.

In February on the 1st at Guernsey and Torquay; on the 2nd at Bath and Oxford; and on the 9th at Bath.

Solar halos were seen in January on the 6th at Halifax; on the 7th at Torquay; on the 12th and 13th at Halifax; on the 21st at Stonyhurst; and on the 29th at Halifax.

In February on the 1st at Oxford; on the 19th at Torquay; and on the 21st and 27th at Oxford.

In March on the 2nd at Oxford; on the 5th at Torquay; on the 6th at Halifax; on the 8th at Oxford; on the 12th at Halifax; on the 17th at Oxford; on the 18th and 21st at Halifax; on the 28th at Torquay; on the 29th at Oxford; and on the 31st at Torquay.

Lunar halos were seen in January on the 24th at Cambridge; on the 27th at Oxford, Cambridge, Lowestoft, Burslem, Halifax, and Bradford; on the 29th, 30th, and 31st at Torquay.

In February on the 23rd at Torquay, Oxford, and Cambridge; on the 24th at Oxford and Cambridge; on the 25th and 27th at Leicester.

In March on the 25th at Guernsey. Torquay, Cambridge, and Stonyhurst; on the 28th at Torquay, Oxford, and Silloth; and on the 31st at Torquay.

Aurora Borealis was seen in February on the 5th at Stonyhurst; and in March on the 15th at Torquay, Brighton, Leicester, and Halifax.

Snow fell in January on the 1st at Cambridge; on the 3rd at Silloth and Carlisle; on the 8th at Bath, Whitchurch, Silloth, and Carlisle; on the 9th at Burslem and Bolton; on the 10th at Torquay, Bolton, and Halifax; on the 12th at Truro, Whitchurch, Barnet, Oxford, Royston, Cardington, Cambridge, Rugby, Lowestoft, Somerleyton, Nottingham, Bradford, and Carlisle; on the 13th at Truro, Eastbourne, Barnet, Oxford, Royston, Cardington, Cambridge, Rugby, Lowestoft, Somerleyton, Nottingham, Burslem, Bolton, Bradford, Leeds, and Carlisle; on the 14th at Guernsey, Torquay, Osborne, Whitchurch, Rugby, Somerleyton, Nottingham, Stonyhurst, Bradford, Leeds, and Silloth; on the 15th at Eastbourne and Royston; on the 17th at Barnet, Oxford, Royston, and Rugby; on the 18th at Torquay.

In February on the 4th at Bath, and Bolton; on the 5th at Burslem, Bolton, Halifax, Stonyhurst, and Carlisle; on the 16th at Nottingham, Bolton, Halifax, and Hull; on the 17th at Cambridge, Leicester, Nottingham, Burslem, Bolton, Halifax, Stonyhurst, and Bradford; on the 18th at Cambridge, Leicester, Burslem, Bolton, Halifax, Stonyhurst, Bradford, and Silloth; on the 19th at Leicester and Burslem; on the 20th at Rugby; on 21st at Carlisle; and on the 22nd at Marlborough, Cambridge, and Rugby.

In March on the 2nd at Halifax, and Bradford; on the 3rd at Halifax; on the 5th at Bolton, Halifax, and Stonyhurst; on the 6th at Marlborough, Whitchurch, Oxford, Royston, Cardington, Cambridge, and Rugby; on the 7th at Barnet; on the 9th at Oxford; on the 10th at Halifax; on the 17th at Oxford and Bolton; on the 18th at Torquay, Marlborough, Barnet, Somerleyton, Nottingham, Bolton, Halifax, Stonyhurst, and Bradford; on the 19th at Lancaster; on the 20th at Bolton; on the 21st at Barnet, Nottingham, Halifax, Bradford, and Lancaster; on the 22nd at Ventnor, Osborne, Salisbury, Marlborough, Blackheath, Barnet, Oxford, Royston, Cardington, Cambridge, Rugby, and Lancaster; and on the 23rd at Southbourne and Somerleyton.

Hail fell in January, on the 6th at Carlisle; on the 8th at Silloth; on the 9th at Truro and Silloth; on the 10th at Guernsey, Torquay, Bath, Oxford, Bolton, and Halifax; on the 11th at Torquay; on the 12th at Truro and Lowestoft; on the 13th at Truro; on the 14th at Truro; on the 27th at Torquay; and on the 31st at Truro, Torquay, Osborne, Salisbury, and Bath.

In February, on the 1st at Guernsey, Totnes, Torquay, and Bath; on the 2nd at Guernsey, Truro, Torquay, and Whitchurch; on the 4th at Totnes, Torquay, Bath, Marlborough, Oxford, Cambridge, and Burslem; on the 5th at Totnes, Torquay, Burslem, Bolton, and Stonyhurst; on the 7th at Torquay, Halifax, and Silloth; on the 9th at Bath and Bolton; on the 18th at Burslem and Bolton; and on the 22nd at Bath, Marlborough, Whitchurch, Royston, and Cambridge.

In March; on the 4th at Guernsey; on the 5th at Barnet and Stonyhurst; on the 9th at Barnet; on the 10th at Cambridge; on the 17th at Whitchurch; on the 18th at Guernsey, Totnes, Torquay, Burslem, and Stonyhurst; on the 19th at Rugby; on the 21st at Rugby and Stonyhurst; on the 23rd at Lowestoft; and on the 27th at Stonyhurst.

MONTHLY METEOROLOGICAL TABLE FOR THE QUARTER ENDING MARCH 31ST, 1885.

The Observations have been reduced to Mean values by Glaisher's Barometrical and Diurnal Range Tables, and the Hygrometrical results have been deduced from the sixth edition of his Hygrometrical Tables.

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1885. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean Of all Highest.	Temperature of Air in Month. Mean Of all Lowest.	Temperature of Air in Month. Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Sat. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									
GUERNSEY, Adolphus Collenette, Esq., F. R. Met. Soc.	270	Jan.	29·576	1·422	50·9	27·4	23·5	44·6	36·8	7·8	40·2	37·5	·224	2·6	0·2	90	548	65·8	32·5	1·2	6	10	12	3	2·5	7·9	21	3·16
		Feb.	29·456	1·086	54·0	33·6	20·4	49·6	41·6	8·0	45·2	43·6	·278	3·1	0·4	94	540	82·1	36·1	1·2	1	3	18	7	4·5	7·1	27	4·95
		Mar.	29·766	1·267	53·6	33·3	20·3	46·9	39·7	7·2	42·7	38·3	·214	2·4	0·6	79	549	85·6	32·7	1·0	8	12	5	6	2·5	6·0	15	1·81
TRURO (Cornwall), N. Whitley, Esq., F. R. Met. Soc.	48	Jan.	29·732	1·592	54·0	24·0	30·0	47·3	38·0	9·3	42·0	37·5	·225	2·6	0·5	85	549	—	—	2·6	6	9	10	6	—	8·0	16	3·12
		Feb.	29·557	1·186	56·0	25·0	31·0	51·8	41·1	10·7	45·8	42·1	·268	3·0	0·5	86	541	—	—	2·6	2	2	11	13	—	7·8	21	5·11
		Mar.	29·973	1·210	57·0	27·0	30·0	51·6	36·7	14·9	42·4	38·0	·229	2·7	0·5	85	553	—	—	2·5	9	10	5	7	—	6·5	13	1·57
PLYMOUTH (Devon), J. Merrifield, Esq., LL.D., F.R.A.S., F. R. Met. Soc.	69	Jan.	29·819	1·540	52·0	23·5	28·5	44·9	36·3	8·6	41·2	38·5	·233	2·7	0·4	88	552	—	—	1·6	5	9	11	6	—	7·0	18	2·56
		Feb.	29·635	1·114	55·0	29·0	26·0	50·6	41·4	9·2	45·8	43·7	·285	3·2	0·3	92	543	—	—	1·6	1	2	7	13	—	7·0	19	3·25
		Mar.	30·072	1·204	57·0	30·0	27·0	49·8	37·3	12·5	43·0	36·4	·215	2·5	0·7	78	554	—	—	1·1	9	11	5	6	—	6·5	11	1·53
TOTNES (Devon), T. H. Edmonds, Esq.	107	Jan.	29·825	1·566	57·8	24·6	33·2	45·1	32·4	12·7	38·8	35·6	·209	2·4	0·4	88	555	—	—	2·5	6	10	10	5	—	7·6	22	3·41
		Feb.	29·644	1·137	54·8	24·6	30·2	51·4	38·3	13·1	45·2	41·5	·262	2·9	0·5	88	544	—	—	2·6	3	1	12	11	—	6·3	21	6·35
		Mar.	30·030	1·228	60·0	24·2	35·8	50·4	34·7	15·7	42·0	37·5	·225	2·6	0·5	85	555	—	—	2·6	11	7	4	9	—	6·3	12	1·52
TORQUAY, Babbacombe (Devon), Edwin E. Glyde, Esq., F. R. Met. Soc.	305	Jan.	29·540	1·604	51·3	29·2	22·1	43·9	37·0	6·9	40·5	37·1	·220	2·6	0·4	88	554	62·4	31·8	1·8	6	8	9	8	4·7	7·5	18	2·71
		Feb.	29·377	1·158	56·6	31·1	25·5	49·8	40·7	9·1	45·0	41·7	·264	3·0	0·4	88	539	84·0	34·2	1·7	3	2	12	11	6·0	6·7	19	4·25
		Mar.	29·746	1·204	58·8	29·5	29·3	48·0	37·6	10·4	42·2	36·2	·214	2·5	0·6	79	549	96·7	30·2	1·6	9	10	4	8	4·4	6·2	10	0·95
VENTNOR, (Isle of Wight) (Royal National Hospital for Consumption), Hartley Sagar, Esq.	80	Jan.	29·782	1·374	49·8	29·5	20·3	43·5	36·8	6·7	39·7	36·0	·212	2·4	0·4	87	553	—	—	1·3	8	8	8	7	5·5	7·8	12	2·03
		Feb.	29·612	0·957	53·3	31·3	22·0	49·3	41·8	7·5	44·8	41·3	·260	3·0	0·4	91	548	—	—	1·0	3	2	9	14	5·7	8·0	23	3·23
		Mar.	29·946	1·289	54·9	32·0	22·9	48·4	38·1	10·3	42·7	36·3	·214	2·4	0·7	79	553	—	—	1·0	9	12	4	6	5·6	5·8	10	1·55
EASTBOURNE, Miss W. L. Hall.	12	1884. Oct.	30·009	1·216	64·9	32·5	32·4	57·9	44·3	13·6	50·4	45·5	·305	3·4	0·7	84	545	63·1	38·6	0·4	9	6	2	14	1·4	—	11	1·73
		Nov.	30·102	0·834	59·1	27·1	32·0	47·2	37·6	9·6	43·1	40·0	·248	2·8	0·6	81	555	62·4	33·6	0·2	13	5	4	8	0·0	—	8	1·21
		Dec.	29·809	0·890	54·4	27·6	26·8	46·7	37·6	9·1	42·6	37·0	·221	2·5	0·4	82	556	53·0	35·3	0·4	8	4	3	16	1·4	—	22	4·45
		1885. Jan.	29·827	1·426	49·3	27·6	21·7	38·0	34·5	3·5	37·3	32·0	·181	2·1	0·6	82	557	52·3	30·1	0·3	7	3	13	8	1·0	—	11	2·51
		Feb.	—	—	53·5	27·0	26·5	48·5	39·5	9·0	44·0	42·0	·267	3·0	0·3	93	—	80·9	35·1	0·3	3	2	11	12	2·4	—	20	3·79
		Mar.																										
OSBORNE (Isle of Wight), J. R. Mann, Esq.	172	Jan.	29·691	1·364	50·9	27·1	23·8	42·2	33·6	8·6	38·0	36·0	·212	2·5	0·2	94	553	56·9	32·8	0·3	7	11	9	4	—	7·3	14	2·23
		Feb.	29·530	1·010	57·8	27·9	29·9	49·2	38·9	10·3	44·0	42·5	·272	3·1	0·2	94	543	75·3	37·9	0·2	1	2	18	7	—	7·4	22	3·07
		Mar.	29·877	1·296	59·7	28·8	30·9	49·1	34·4	14·7	40·8	36·7	·217	2·5	0·5	86	553	93·6	32·7	0·2	11	9	7	4	—	5·0	10	1·69
BRIGHTON, F. E. Sawyer, Esq., F.S.A., F.R. Met. Soc.	206	Jan.	29·691	1·408	48·0	24·8	23·2	40·1	33·9	6·2	37·1	34·0	·195	2·2	0·4	89	554	—	29·9	1·2	7	11	9	4	—	7·7	9	1·81
		Feb.	29·531	1·083	54·0	29·0	25·0	47·6	39·2	8·4	43·5	40·9	·256	2·9	0·3	90	544	—	32·8	1·0	2	4	11	11	—	7·8	22	3·37
		Mar.	29·851	1·338	52·8	30·6	22·2	46·9	35·0	11·9	40·5	33·7	·193	2·3	0·7	77	553	—	29·5	1·3	7	11	6	7	—	5·7	11	2·06
SOUTHBOURNE, (near) Bournemouth (Hants), T. A. Compton, Esq., M.D., B.A., F. R. Met. Soc.	95	Jan.	29·808	1·388	49·3	26·0	23·3	42·4	34·7	7·7	38·7	34·5	·200	2·2	0·5	86	555	—	—	1·7	8	11	6	6	—	6·5	13	1·60
		Feb.	29·599	1·014	56·0	26·1	29·9	48·2	40·2	8·0	44·0	40·9	·256	2·9	0·4	79	544	—	—	1·5	4	2	12	10	—	5·9	19	3·97
		Mar.	29·958	1·332	56·9	28·7	28·2	47·6	34·9	12·7	41·0	35·1	·208	2·4	0·6	79	555	—	—	1·6	13	9	3	6	—	5·0	10	1·62
SALISBURY (Wilton House), Wilts, Thomas Challis, Esq.	186	Jan.	29·665	1·366	52·0	21·0	31·0	41·7	29·6	12·1	36·6	—	—	—	—	—	—	53·4	—	1·3	11	10	3	7	—	7·8	21	2·94
		Feb.	29·508	0·962	65·0	18·0	47·0	50·6	35·1	15·5	43·1	41·4	·261	3·0	0·2	93	544	73·8	—	1·2	4	1	14	9	—	6·9	23	4·22
		Mar.	29·876	1·278	60·0	22·0	38·0	50·2	29·4	20·8	39·8	—	—	—	—	—	—	96·5	28·0	1·6	15	5	6	5	—	5·5	14	1·87

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1885. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean Of all Highest.	Temperature of Air in Month. Mean Of all Lowest.	Temperature of Air in Month. Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a Cubic foot of Air. Mean.	Vapour. In a Cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	Wind. Relative Proportion of E.	Wind. Relative Proportion of S.	Wind. Relative Proportion of W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
BARNSTAPLE (Devon),	43	Jan.	29·822	1·460	56·0	30·0	26·0	46·0	37·5	8·5	41·7	37·0	·231	2·5	0·5	85	551	–	–	1·3	4	7	13	7	–	5·7	18	3·16
William Knill, Esq.		Feb.	29·642	1·180	60·0	28·0	32·0	51·7	41·2	10·5	46·2	42·8	·275	3·2	0·3	89	543	–	–	1·3	1	2	14	11	–	5·0	21	3·94
		Mar.	30·058	1·180	54·0	28·0	26·0	50·2	37·1	13·1	43·3	37·9	·227	2·6	0·6	81	554	–	–	1·2	11	6	7	7	–	2·8	13	1·92
BATH (Somerset), St. Gregory's	596	Jan.	29·900	1·422	49·8	24·2	25·6	39·9	33·0	6·9	36·4	34·8	·202	2·3	0·2	94	546	54·8	24·8	2·1	8	7	11	5	–	8·2	19	4·67
College, Downside,		Feb.	29·033	1·066	55·3	22·4	32·9	47·2	37·7	9·5	42·4	38·7	·235	2·7	0·5	80	536	76·6	26·9	2·0	2	2	14	10	–	6·8	21	4·80
Rev. T. J. Almond, O.S.B.		Mar.	29·433	1·272	54·3	20·2	23·1	46·4	33·1	13·3	39·1	34·5	·200	2·3	0·5	84	547	94·1	22·1	2·0	9	9	4	9	–	5·9	8	1·18
MARLBOROUGH (Wilts),	456	Jan.	29·361	1·396	50·1	24·6	25·5	39·7	32·6	7·1	36·1	33·7	·194	2·2	0·3	91	549	54·2	29·6	1·0	4	9	11	7	–	8·1	20	3·06
Rev. Thomas A. Preston, M.A.,		Feb.	29·155	1·040	56·0	23·2	32·8	47·8	37·9	9·9	42·5	39·6	·243	2·9	0·2	90	538	77·5	32·7	1·0	2	2	13	11	–	7·0	19	4·70
F. R. Met. Soc.		Mar.	29·562	1·258	58·1	24·2	33·9	47·1	32·1	15·0	39·0	33·8	·195	2·3	0·5	83	549	96·7	25·1	0·7	7	11	7	6	–	6·2	11	1·34
BLACKHEATH (Kent),	150	Jan.	29·723	1·516	52·0	22·5	29·5	40·8	31·8	9·0	35·0	32·7	·186	2·1	0·2	91	557	55·5	28·6	0·9	4	14	9	4	–	7·5	12	1·15
James Glaisher, Esq., F.R.S.		Feb.	29·541	1·157	57·5	26·0	31·5	49·6	38·0	11·6	43·6	40·5	·253	3·0	0·3	89	544	74·5	31·3	0·9	2	4	9	13	–	6·6	17	2·18
		Mar.	29·900	1·368	58·0	25·0	33·0	48·0	32·6	15·4	39·5	34·4	·200	2·4	0·5	82	555	96·8	26·7	0·5	6	11	5	7	–	4·8	6	1·46
ROYAL OBSERVATORY, Greenwich,	159	Jan.	29·713	1·466	52·8	22·3	30·5	40·2	32·3	7·9	36·6	33·4	·191	2·3	0·3	88	555	51·5	29·1	–	–	–	–	–	2·0	7·9	15	1·42
W. H. M. Christie, M.A., F.R.S.,		Feb.	29·543	1·118	58·3	26·9	31·4	49·4	38·6	10·8	43·9	40·1	·248	2·9	0·4	86	548	78·0	35·3	–	–	–	–	–	4·9	7·3	19	2·34
Astronomer Royal.		Mar.	29·900	1·342	60·2	25·2	35·0	49·0	32·5	16·5	40·3	33·8	·194	2·3	0·7	78	554	94·2	26·7	–	–	–	–	–	1·8	6·3	8	1·50
WHITCHURCH RECTORY (Oxon),	150	Jan.	29·729	1·420	53·8	23·5	30·3	40·6	31·7	8·9	36·8	34·9	·204	2·5	0·2	93	535	–	–	1·2	4	13	8	6	–	8·3	15	1·90
(near Reading),		Feb.	29·549	0·993	58·7	22·2	36·5	49·1	36·2	12·9	42·6	40·8	·255	2·9	0·3	92	545	–	–	1·1	2	2	11	13	–	7·3	21	3·00
Rev. J. Slatter, M.A., F.R. Met. Soc.		Mar.	29·983	1·302	60·0	21·1	38·9	48·6	32·0	16·6	39·9	36·6	·218	2·5	0·4	89	553	–	–	1·1	8	9	4	10	–	5·5	8	1·85
CAMDEN SQUARE (London),	123	Jan.	29·757	1·475	53·3	22·8	30·5	41·0	32·2	8·8	36·6	33·2	·190	2·2	0·3	88	556	45·6	28·4	–	6	11	8	6	–	8·1	16	1·48
G. J. Symons, Esq., F.R.S.,		Feb.	29·381	0·960	57·8	27·6	30·2	49·9	38·7	11·2	44·0	39·4	·242	2·7	0·5	83	544	62·1	33·5	–	1	6	17	4	–	6·6	18	2·84
F. R. Met. Soc.		Mar.	29·913	1·325	62·6	26·5	36·1	49·4	33·0	16·4	40·6	33·6	·193	2·2	0·7	76	555	78·7	28·0	–	11	10	4	6	–	5·8	7	1·65
BARNET (Gas Works),	212	Jan.	29·696	1·502	53·3	17·8	35·5	39·9	29·6	10·3	35·1	33·6	·198	2·2	0·2	94	556	49·6	27·8	1·0	3	11	9	8	–	8·1	11	1·42
T. H. Martin, Esq., C.E.		Feb.	29·514	1·059	57·9	19·1	38·8	49·6	35·5	14·1	42·7	39·6	·244	2·8	0·4	89	544	78·0	32·6	0·8	2	2	9	15	–	7·4	17	3·23
		Mar.	29·866	1·322	61·2	19·5	45·7	49·2	29·9	19·3	39·1	33·3	·191	2·2	0·6	81	555	100·6	26·4	0·8	8	13	4	6	–	5·6	6	1·51
OXFORD (The Observatory),	210	Jan.	29·637	1·454	52·0	25·2	26·8	41·2	33·5	7·7	37·3	34·2	·197	2·3	0·4	89	553	52·8	29·5	3·2	6	8	12	5	0·8	7·8	12	1·89
E. J. Stone, Esq., M.A., F.R.S.		Feb.	29·467	1·070	57·3	24·2	33·1	50·0	39·5	10·5	44·3	40·2	·249	2·9	0·4	85	542	80·9	34·3	3·3	3	1	18	6	1·0	6·6	18	2·94
		Mar.	29·842	1·296	58·7	27·6	31·1	49·2	34·4	14·8	41·4	36·1	·213	2·5	0·6	81	552	95·1	28·3	2·7	11	6	8	6	3·3	6·1	9	1·18
ROYSTON (Hertfordshire),	269	Jan.	29·645	1·373	53·7	23·7	30·0	40·9	32·0	8·9	36·2	33·5	·193	2·2	0·3	90	554	–	–	–	5	7	13	6	–	7·5	14	1·64
Hale Wortham, Esq., F.R.A.S.,		Feb.	29·424	1·079	57·3	22·2	35·1	48·5	37·2	11·3	42·8	37·7	·227	2·6	0·5	83	542	–	–	–	3	2	16	7	–	6·7	17	1·89
F. R. Met. Soc.		Mar.	29·804	1·327	59·1	26·5	32·6	49·3	31·9	17·4	39·5	34·8	·202	2·3	0·5	84	553	–	–	–	10	6	17	8	–	5·7	16	0·96
*BEDFORD, Cardington,	105	Jan.	29·781	1·530	54·0	20·0	34·0	40·6	31·7	8·9	35·8	33·8	·195	2·2	0·2	92	557	42·4	29·4	1·9	4	7	12	8	–	7·5	12	1·40
Mr. J. McLaren, Assistant to		Feb.	29·574	1·060	59·4	21·0	38·4	50·0	37·0	13·0	43·0	39·3	·240	2·8	0·4	86	545	60·4	33·1	1·4	3	2	10	13	–	6·7	15	1·68
S. Whitbread, Esq., M.P.		Mar.	29·963	1·310	61·2	23·0	38·2	50·1	31·5	18·6	40·4	34·5	·200	2·5	0·6	80	554	76·3	27·7	0·9	10	7	5	9	–	5·4	5	1·16
CAMBRIDGE (Trinity College),	40	Jan.	29·827	1·584	55·0	20·0	35·0	40·8	31·4	9·4	36·3	34·3	·200	2·2	0·3	94	558	52·7	27·9	1·3	4	8	13	6	–	7·5	18	1·63
J. W. L. Glaisher, Esq., M.A.,		Feb.	29·615	1·120	58·9	20·0	38·9	50·0	36·5	13·5	42·9	40·2	·250	2·9	0·3	91	546	76·3	31·6	1·3	3	1	13	11	–	7·3	18	1·57
F.R.S.		Mar.	30·006	1·336	60·0	23·0	37·0	50·3	31·0	19·3	39·8	34·6	·201	2·3	0·6	82	557	103·0	26·6	1·3	8	5	7	11	–	5·7	6	0·83
RUGBY (Warwickshire),	289	Jan.	29·530	1·862	52·0	19·0	33·0	39·9	30·2	9·7	35·4	33·9	·198	2·2	0·4	94	553	–	–	0·7	4	12	11	4	–	8·4	18	1·44
Stockton, The Rectory,		Feb.	29·314	1·044	57·0	20·5	36·5	49·0	34·9	14·1	41·9	39·7	·244	2·9	0·4	93	541	–	–	0·7	1	5	17	5	–	7·5	17	2·70
Rev. W. Tuckwell.		Mar.	29·726	1·430	55·2	22·8	32·4	48·3	31·2	17·1	39·4	35·4	·208	2·4	0·4	87	552	–	–	0·7	6	8	7	10	–	6·7	13	0·76
LOWESTOFT (Suffolk),	89	Jan.	29·800	1·636	50·7	28·0	22·7	40·4	34·0	6·4	37·2	34·6	·202	2·4	0·2	90	556	57·0	31·2	2·1	3	6	13	9	–	7·0	14	1·79
S. H. Miller, Esq., F.R.A.S.,		Feb.	29·600	1·024	55·0	31·0	24·0	45·1	37·9	7·2	41·6	39·7	·244	2·8	0·2	88	557	74·1	30·9	2·0	4	2	9	13	–	7·0	14	1·70
F. R. Met. Soc.		Mar.	29·919	1·374	56·6	29·0	27·6	46·4	34·1	12·3	40·1	34·8	·202	2·3	0·5	81	556	93·5	28·3	2·0	11	8	5	7	–	5·4	12	0·87

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1885. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Sat. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs	°	°									in.
SOMERLEYTON (Suffolk), The Rectory,	50	Jan.	29·836	1·682	51·3	25·4	25·9	40·6	33·6	8·0	36·4	34·5	·200	2·3	0·5	91	558	—	—	1·0	3	10	12	6	5·7	6·7	15	1·94
Rev. C. J. Steward, F.R. Met. Soc.		Feb.	29·536	1·060	53·2	28·7	26·5	47·9	37·1	10·8	42·0	40·2	·249	2·9	0·2	94	545	—	—	1·1	1	3	14	10	6·0	6·6	18	2·32
		Mar.	29·983	1·375	57·6	25·7	31·9	47·3	33·0	14·3	39·4	35·1	·204	2·4	0·5	85	557	—	—	1·1	7	9	5	10	6·5	4·5	9	0·84
WOLVERHAMPTON (Staffordshire), Wrottesley,	500	Jan.	29·339	1·384	51·2	21·2	30·0	39·2	30·1	9·1	35·0	31·6	·178	2·1	0·3	87	550	—	—	—	4	10	14	3	—	7·0	15	2·01
E. Simpson, Esq.		Feb.	29·115	1·054	57·0	21·8	35·2	46·8	34·0	12·8	40·4	38·1	·230	2·7	0·3	92	540	—	—	—	2	4	17	5	—	8·0	15	2·27
		Mar.	29·563	1·344	55·5	25·6	29·9	45·9	31·5	14·4	37·9	34·1	·195	2·3	0·4	85	551	—	—	—	11	5	10	5	—	7·1	10	1·08
LEICESTER (Town Museum),	238	Jan.	29·591	1·572	52·2	22·5	29·7	40·0	32·7	7·3	36·5	33·1	·189	2·2	0·4	88	553	42·8	28·1	0·9	3	8	14	6	—	8·0	17	3·69
J. C. Smith, Esq.		Feb.	29·876	1·137	58·5	22·0	36·5	48·7	37·0	11·7	42·8	38·8	·233	2·7	0·5	86	542	72·0	30·2	0·9	2	3	13	10	—	6·9	17	2·79
		Mar.	29·795	1·322	56·2	28·7	27·5	48·2	33·8	14·4	40·3	35·2	·203	2·4	0·6	84	552	83·8	24·8	0·6	9	5	8	9	—	5·8	15	1·05
NOTTINGHAM (Notts),	123	Jan.	29·720	1·620	53·1	25·6	27·5	40·5	32·9	7·6	37·0	34·4	·198	2·3	0·3	90	555	48·0	39·9	0·2	3	6	17	5	0·5	6·9	20	1·92
M. O. Tarbotton, Esq., C.E., F.G.S.,		Feb.	29·473	1·107	58·0	26·0	32·0	48·1	37·6	10·5	42·6	39·5	·243	2·8	0·4	89	544	70·9	31·7	0·2	1	3	15	9	0·4	6·9	26	2·58
F. R. Met. Soc.		Mar.	29·922	1·278	53·9	28·3	25·6	47·1	31·7	12·4	40·2	34·7	·202	2·3	0·6	81	555	82·8	29·1	0·2	5	10	7	9	0·2	5·8	21	0·82
HOLKHAM (Norfolk),	39	Jan.	29·800	1·722	53·5	21·1	32·4	40·1	29·8	10·3	35·7	32·3	·185	2·3	0·4	88	558	50·7	24·1	1·1	4	6	18	3	—	7·5	11	2·65
John Davidson, Esq., Assistant		Feb.	29·608	1·122	53·8	21·7	31·1	47·3	34·3	13·0	41·5	37·7	·227	2·6	0·5	87	548	68·7	28·2	1·6	2	2	20	4	—	7·3	14	2·12
to the Earl of Leicester.		Mar	29·990	1·444	51·7	23·3	31·4	47·1	29·9	17·2	38·7	32·4	·184	2·1	0·6	79	558	89·9	25·3	1·1	11	4	9	7	—	4·9	9	1·00
BURSLEM,	556	Jan.	29·230	1·478	50·6	24·1	26·5	38·8	31·4	7·4	35·2	32·9	·187	2·1	0·3	91	548	—	28·3	1·2	3	10	14	4	—	8·1	17	1·45
J. E. Worth, Esq., C.E.,		Feb.	29·006	1·101	56·1	26·1	30·0	45·4	35·5	9·9	40·4	37·7	·226	2·6	0·3	90	537	—	31·4	1·2	2	5	13	8	—	6·4	22	2·46
F. R. Met. Soc.		Mar.	29·444	1·340	52·0	27·2	24·8	45·1	32·7	12·4	38·4	31·6	·200	2·3	0·4	87	548	—	27·5	0·9	10	6	8	7	—	6·3	16	1·32
LLANDUDNO (Carnarvonshire),	100	Jan.	29·665	1·590	55·2	27·0	[illegible]·2	48·4	36·6	6·8	40·3	35·4	·207	2·5	0·5	84	550	—	—	1·4	3	6	10	12	—	7·7	15	3·26
James Nicol, Esq., M.D.		Feb.	29·456	1·170	57·2	20·2	[illegible]·0	48·0	38·8	9·2	43·4	39·1	·233	2·8	0·6	84	543	—	—	1·4	4	3	8	13	—	6·9	20	2·31
		Mar	29·953	1·404	55·6	30·5	[illegible]·1	46·0	35·5	10·4	41·7	35·9	·211	2·4	0·6	81	554	—	—	1·1	10	6	8	7	—	6·1	12	1·88
LIVERPOOL, The Observatory,	197	Jan.	29·596	1·589	54·1	26·6	27·5	41·2	34·4	6·8	37·6	33·6	·193	2·2	0·4	86	552	—	—	1·8	3	16	8	4	—	7·3	15	1·26
John Hartnup, Esq., F.R.A.S.		Feb.	29·355	1·206	58·9	28·0	30·9	47·3	38·1	9·2	42·1	37·6	·226	2·6	0·5	85	542	—	—	1·6	2	6	14	6	—	6·8	21	2·54
		Mar.	29·820	1·345	50·6	31·7	18·9	45·3	36·0	9·3	39·9	34·1	·196	2·3	0·5	80	558	—	—	1·2	5	7	9	10	—	6·1	15	1·27
BOLTON, Sharples (Lancashire),	500	Jan.	29·288	1·506	51·3	21·7	29·6	39·9	30·1	9·8	35·4	32·3	·182	2·2	0·3	89	549	41·6	30·7	0·9	5	9	12	5	2·0	7·6	18	3·34
Rev. T. Mackereth, F.R.A.S.,		Feb.	29·052	1·159	55·8	23·1	32·7	44·7	34·7	10·0	40·1	37·1	·221	2·6	0·4	90	539	48·9	33·6	0·8	3	4	12	9	2·4	7·6	23	4·35
F. R. Met. Soc.		Mar.	29·506	1·330	50·3	26·6	23·7	44·6	32·4	12·2	38·0	33·0	·188	2·2	0·5	83	550	52·4	30·9	0·8	10	8	6	7	3·5	6·7	17	3·55
HALIFAX, Bermerside Observatory (Yorkshire),	580	Jan.	29·319	1·604	53·0	23·0	30·0	37·7	31·3	6·4	34·6	32·0	·181	2·1	0·3	91	550	45·4	28·8	1·1	4	11	9	7	—	8·3	14	2·28
E. J. Crossley, Esq., F.R.A.S.		Feb.	29·057	0·971	58·0	20·2	37·8	45·3	34·1	11·2	39·5	36·9	·220	2·6	0·3	91	539	67·9	31·3	1·5	3	4	11	10	—	7·9	24	3·65
		Mar.	29·508	1·260	53·0	26·0	27·0	44·7	31·5	13·2	37·5	31·7	·179	2·1	0·6	81	550	71·6	27·0	0·4	7	8	6	10	—	6·6	13	1·85
HULL (Yorkshire), The People's Park,	12	Jan.	29·813	1·672	53·0	23·0	30·0	40·2	31·4	8·8	36·5	32·8	·187	2·2	0·4	87	557	43·1	30·7	1·4	4	8	12	7	—	7·9	18	1·79
Mr. E. Peak.		Feb.	29·584	1·022	56·0	23·0	33·0	46·7	35·2	11·5	41·4	36·4	·216	2·5	0·6	84	547	55·9	33·2	1·4	9	4	11	13	—	5·7	18	2·33
		Mar.	30·053	1·178	54·0	26·0	28·0	47·0	31·5	15·5	39·5	34·2	·198	2·4	0·5	82	557	67·1	30·2	1·2	6	6	7	12	—	6·4	15	1·88
STONYHURST (Lancashire),	363	Jan.	29·484	1·577	52·3	22·5	29·8	41·3	31·5	9·8	36·6	33·0	·188	2·1	0·4	87	550	53·9	28·6	—	5	12	8	6	—	8·7	14	3·52
Rev. S. J. Perry, F.R.S.,		Feb.	29·195	1·156	56·9	19·1	37·8	46·6	33·9	12·7	40·4	36·6	·218	2·5	0·5	87	541	75·4	30·9	—	2	3	12	11	—	8·5	23	3·08
F. R. Met. Soc., F.R.A.S.		Mar.	29·663	1·329	54·1	22·9	31·2	46·5	31·0	15·5	38·3	33·4	·191	2·2	0·4	83	552	90·9	27·2	—	8	7	4	12	—	7·1	18	3·79
BRADFORD (Yorkshire),	366	Jan.	29·454	1·600	53·8	25·0	28·8	40·9	33·1	7·8	37·1	33·5	·192	2·2	0·4	87	550	41·8	—	0·6	4	11	12	4	—	9·0	18	1·72
J. McLandsborough, Esq., C.E.,		Feb.	29·176	1·188	58·0	24·0	34·0	47·5	36·4	11·1	41·5	37·7	·226	2·6	0·4	87	540	52·5	—	0·9	3	3	12	10	—	7·9	26	2·77
F.G.S.		Mar.	29·624	1·289	51·3	30·0	21·3	45·3	33·9	11·4	38·8	32·7	·186	2·2	0·6	80	551	58·1	—	0·7	13	7	4	7	—	7·6	24	1·50
LEEDS (Yorkshire), The Philosophical Hall,	137	Jan.	29·690	1·620	56·0	25·0	31·0	41·0	34·1	6·9	37·6	34·7	·202	2·3	0·3	89	553	—	—	1·1	5	9	10	7	—	8·0	16	1·29
Henry Crowther, Esq.		Feb.	29·478	1·144	60·0	25·0	35·0	47·6	38·8	9·8	42·1	38·1	·230	2·7	0·4	86	544	—	—	1·1	4	4	10	10	—	7·6	22	2·14
		Mar.	29·898	1·262	54·0	31·0	23·0	40·6	35·3	11·3	40·5	31·8	·190	2·3	0·7	80	554	—	—	1·4	9	5	7	10	—	6·8	14	1·81

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1885. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Sat. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
LANCASTER (Southfields), William Roper, Esq.	114	Jan.	29·704	1·883	53·0	23·5	29·5	41·8	33·1	8·7	38·1	34·9	·204	2·4	0·3	88	553	—	—	—	4	7	18	2	—	—	18	2·83
		Feb.	29·451	1·188	56·0	25·0	31·0	46·2	37·0	9·2	41·2	38·3	·231	2·6	0·3	90	545	—	—	—	1	1	18	8	—	—	24	3·88
		Mar.	29·920	1·303	52·5	26·5	26·0	46·6	32·6	14·0	39·1	34·8	·202	2·4	0·4	85	556	—	—	—	7	9	8	7	—	—	16	3·57
SILLOTH (Cumberland), "The Rectory," Rev. F. Redford, M.A., F.R.A.S., F. R. Met. Soc.	28	Jan.	29·764	1·806	51·0	21·8	29·2	41·9	33·4	8·5	37·5	34·3	·197	2·3	0·4	88	555	63·0	27·9	1·6	5	13	6	7	8·4	6·3	14	1·95
		Feb.	30·478	1·336	52·0	23·8	28·2	46·2	36·3	9·9	40·8	37·4	·223	2·6	0·4	88	546	76·7	31·6	1·9	4	5	8	11	11·7	6·4	21	3·83
		Mar.	30·006	1·380	53·2	26·4	26·8	46·4	33·5	12·9	39·3	35·1	·204	2·3	0·5	84	557	92·5	28·5	1·6	4	13	6	8	8·1	6·4	15	2·59
CARLISLE, Spital (Cumberland), Isaac Cartmel, Esq., F. R. Met. Soc	114	Jan.	29·684	1·872	53·2	20·3	32·9	41·8	31·9	9·9	37·2	33·6	·193	2·2	0·4	87	554	51·4	27·8	1·0	2	14	4	11	2·3	8·1	13	1·74
		Feb.	29·875	1·172	57·8	20·0	37·8	47·2	34·2	13·0	40·5	36·2	·213	2·5	0·5	86	543	59·9	30·3	0·8	2	7	5	14	2·9	8·4	15	2·04
		Mar.	29·894	1·354	53·6	21·8	31·8	47·8	31·0	16·8	39·1	33·3	·191	2·2	0·6	78	556	71·6	25·6	0·8	3	10	7	11	2·6	8·4	11	1·90

Second Rain-gauges are placed—

			1884. October.	1884. November.	1884. December.	1885. January.	1885. February.	1885. March.	Total in Quarter inches.
At Eastbourne, at the height of 160 feet *above the sea*; the amount collected was			1·69 inches.	1·52 inches.	4·84 inches.	2·41 inches.	3·67 inches.	inches.	
„ Beachy Head	515	„	Oct. and Nov. 2·30 ins.		3·20	1·98	2·79		
„ „	495	„	2·55		2·88	2·10	3·16		
„ Oxford	23	ground	0·83	1·07	2·71	1·84	2·85	0·93	5·67
„ Cardington	21	„	1·26	1·18	1·58	1·88	1·73	—	—
„ Nottingham	48	„	0·67	0·76	1·97	1·42	1·92	0·74	4·08
„ Holkham	4	„	2·89	1·99	2·21	—	1·95	—	—

Fog prevailed in January, on the 1st at Guernsey, Bath, Barnet, and Leeds; on the 2nd at Barnet, Cambridge, and Leeds; on the 3rd at Totnes, Torquay, Barnet, and Leeds; on the 4th at Totnes, Torquay, Eastbourne, Whitchurch, Barnet, Rugby, Wolverhampton, and Bradford; on the 5th at Osborne and Lowestoft; on the 6th at Oxford and Bolton; on the 7th at Eastbourne, Oxford, and Cambridge; on the 9th at Totnes, Whitchurch, Barnet, Oxford, and Wolverhampton; on the 14th at Cambridge; on the 17th, 18th, and 19th at Totnes; on the 20th at Totnes, Bath, Cambridge, Wolverhampton, Bradford, and Lancaster; on the 21st at Guernsey, Totnes, and Wolverhampton; on the 22nd at Guernsey, Oxford, Cambridge, Rugby, and Wolverhampton; on the 23rd at Bath, Whitchurch, Oxford, Cardington, Cambridge, Wolverhampton, Nottingam, Bradford, and Leeds; on the 24th at Bath, Whitchurch, Barnet, Oxford, Cambridge, Wolverhampton, and Bradford; on the 25th at Totnes, Torquay, Bath, Whitchurch, Oxford, Cambridge, and Wolverhampton; on the 26th at Torquay, Whitchurch, Oxford, Cambridge, Lowestoft, and Bolton; and on the 27th at Lowestoft.

In February, on the 4th at Whitchurch, Barnet, Cambridge, and Somerleyton; on the 5th at Wolverhampton; on the 10th at Southbourne, Whitchurch, and Lowestoft; on the 11th at Guernsey; on the 12th at Guernsey, Torquay, and Southbourne; on the 13th at Guernsey; on the 14th at Bath; on the 15th at Guernsey, Torquay, and Bath; on the 16th at Guernsey, Torquay, Bath, Whitchurch, Cambridge, Lowestoft, and Somerleyton; on the 17th at Bath, Wolverhampton, and Bolton; on the 21st at Cambridge; on the 23rd at Royston; on the 24th at Bath; on the 25th at Totnes, Torquay, Bath, Cambridge, and Wolverhampton; on the 26th at Lowestoft; and on the 28th at Torquay.

In March, on the 2nd at Guernsey; on the 7th at Blackheath and Royston; on the 8th at Blackheath, Barnet, and Cambridge; on the 12th at Cambridge; on the 15th at Totnes; on the 16th at Totnes and Blackheath; on the 24th at Barnet; on the 31st at Cambridge.

NAMES OF STATIONS.	Mean Pressure of dry Air reduced to the level of the Sea.	Highest Reading of the Thermometer.	Lowest Reading of the Thermometer.	Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	WIND. Mean Estimated Strength.	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	RAIN. Number of Days on which it fell.	Amount collected.
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
Guernsey - - -	29·662	54·0	27·4	26·6	47·0	39·4	21·4	7·7	42·7	38·8	·237	2·7	0·4	88	544	77·7	38·8	1·1	5	8	12	5	3·2	7·0	63	9·92
Truro - - - -	29·560	57·0	24·0	33·0	50·2	38·6	30·2	11·6	48·4	39·2	·241	2·8	0·5	85	548	—	—	2·6	6	7	9	9	—	7·4	50	9·80
Plymouth - - -	29·678	57·0	28·5	28·5	48·4	38·3	25·5	10·1	43·3	39·5	·244	2·8	0·5	86	550	—	—	1·4	5	7	8	11	—	6·8	48	7·14
Totnes - - -	29·720	60·0	24·2	35·8	49·0	35·1	33·1	13·8	42·0	38·2	·232	2·6	0·5	87	551	—	—	2·6	7	6	9	8	—	6·7	56	11·28
Torquay - - -	29·653	58·8	29·2	29·6	47·2	38·4	25·3	8·8	42·6	38·3	·233	2·7	0·5	85	547	81·0	32·1	1·7	6	7	8	9	5·0	6·8	47	7·91
Ventnor - - -	29·638	54·9	29·5	25·4	47·1	38·9	21·7	8·2	42·4	37·9	·229	2·6	0·5	86	550	—	—	1·1	7	7	7	9	5·6	7·2	45	6·81
Osborne - - -	29·652	59·7	27·1	32·6	46·8	35·6	28·2	11·2	40·9	38·4	·234	2·8	0·3	90	550	75·6	34·5	0·2	16	7	12	5	—	6·6	46	6·99
Southbourne - -	29·672	56·9	26·0	30·9	46·1	36·6	27·1	9·5	41·2	36·8	·221	2·5	0·5	82	551	—	—	1·6	8	7	7	7	—	5·8	42	7·19
Brighton - - -	29·702	54·0	24·8	29·2	44·9	36·0	23·5	8·8	40·4	36·2	·215	2·5	0·5	85	550	—	30·7	1·2	5	9	9	7	—	7·1	42	7·24
Salisbury - - -	—	65·0	18·0	47·0	47·5	31·4	38·7	16·1	39·8	—	—	—	—	—	—	71·2	—	1·4	10	5	8	7	—	6·7	58	9·08
Barnstaple - - -	29·647	60·0	28·0	32·0	49·3	38·6	28·0	10·7	43·7	39·2	·241	2·8	0·5	85	549	—	—	1·3	5	5	11	8	—	4·5	52	9·02
Bath - - - -	29·660	55·3	22·4	32·9	44·5	34·0	28·9	9·9	39·3	36·0	·212	2·4	0·4	86	543	75·2	24·6	2·0	6	6	10	8	—	7·0	48	10·65
Marlborough - -	29·656	58·1	23·2	34·9	44·9	34·2	30·7	10·7	39·2	35·7	·211	2·5	0·3	83	545	76·1	29·1	0·9	4	7	10	8	—	7·1	50	9·10
Whitchurch - -	29·676	60·0	22·2	37·8	46·1	33·3	34·9	12·8	39·8	37·4	·226	2·6	0·3	91	548	—	—	1·1	5	8	8	10	—	7·0	44	6·75
Blackheath - -	29·675	58·0	22·5	35·5	46·0	34·0	31·3	12·0	39·4	35·9	·213	2·5	0·3	87	552	75·6	27·2	0·8	5	10	8	8	—	6·8	35	4·79
Royal Observatory -	29·682	60·2	22·3	37·9	46·2	34·5	32·3	11·7	40·3	35·7	·211	2·5	0·5	84	551	72·9	30·4	—	-	-	-	-	2·9	7·2	42	5·26
Camden Square -	29·690	62·6	22·8	39·8	46·8	34·6	32·3	12·1	40·4	35·4	·208	2·4	0·5	82	552	62·1	30·0	—	6	9	10	5	—	6·8	41	5·94
Barnet - - -	29·714	61·2	19·1	42·1	46·2	31·7	38·7	14·6	39·0	35·5	·209	2·4	0·4	88	552	76·1	28·9	0·9	4	9	7	10	—	7·0	34	6·16
Oxford - - -	29·660	58·7	24·2	34·5	46·8	35·8	30·3	11·0	41·0	36·8	·220	2·6	0·5	85	549	76·3	30·7	3·1	7	5	10	6	1·7	6·8	39	6·01
Royston - - -	29·710	59·1	22·2	36·9	46·2	33·7	29·2	12·5	39·5	35·3	·207	2·4	0·4	86	550	—	—	—	6	5	12	7	—	6·6	47	4·49
Cardington - - -	29·677	61·2	20·0	41·2	46·9	33·4	36·9	13·2	39·7	32·2	·212	2·5	0·4	86	552	59·7	30·1	1·4	6	5	9	10	—	6·5	32	4·24
Cambridge - - -	29·643	60·0	20·0	40·0	47·0	33·0	37·0	14·0	39·7	36·4	·217	2·5	0·4	89	554	77·3	28·7	1·3	5	5	11	9	—	6·8	42	4·03
Rugby - - -	29·620	57·0	19·0	38·0	45·7	32·1	34·0	13·6	38·9	36·3	·216	2·5	0·4	91	549	—	—	0·7	4	8	12	6	—	7·5	48	4·90
Lowestoft - - -	29·665	56·6	28·0	28·6	44·0	35·3	24·8	8·6	39·6	36·4	·216	2·5	0·3	86	556	54·9	30·1	2·0	6	5	9	10	—	6·5	40	4·36
Somerleyton - -	29·623	57·6	25·4	32·2	45·3	34·2	28·1	11·0	39·3	36·6	·218	2·5	0·4	90	553	—	—	1·1	4	7	10	9	6·1	5·9	42	5·10
Wolverhampton -	29·683	57·0	21·2	35·8	44·0	31·9	31·7	12·1	37·8	34·6	·201	2·4	0·3	88	547	—	—	—	6	6	14	4	—	8·4	40	5·31
Leicester - - -	29·639	58·5	22·0	36·5	45·6	34·5	31·2	11·1	39·9	35·7	·210	2·4	0·5	86	549	66·2	27·7	0·8	5	5	12	8	—	6·9	49	7·53
Nottingham - -	29·627	58·0	25·6	32·4	45·2	35·1	28·4	10·2	39·9	36·2	·214	2·5	0·4	87	551	50·4	33·6	0·2	3	6	13	8	0·4	6·5	67	5·32
Burslem - - -	29·631	58·1	24·1	32·0	48·1	33·2	27·1	9·9	38·0	35·1	·204	2·3	0·9	89	544	—	29·1	1·1	5	7	12	6	—	6·9	55	5·23
Holkham - - -	29·643	56·8	21·1	35·7	44·8	31·8	33·0	13·5	38·6	34·1	·199	2·3	0·5	85	555	69·8	25·9	1·3	6	4	16	5	—	6·6	34	5·77
Llandudno - - -	29·581	57·2	27·0	30·2	46·1	37·3	27·1	8·8	41·8	36·8	·219	2·6	0·6	83	549	—	—	1·3	6	5	9	11	—	6·9	47	7·45
Liverpool - - -	29·509	58·9	26·6	32·3	44·6	36·2	22·4	8·4	39·9	35·1	·206	2·4	0·5	84	549	—	—	1·5	3	10	10	7	—	6·7	51	5·07
Bolton - - -	29·630	55·8	21·7	34·1	43·1	32·4	28·7	10·7	37·8	34·1	·197	2·3	0·4	87	548	47·6	31·7	0·8	6	7	10	7	2·8	7·3	58	11·24
Halifax - - -	29·640	58·0	20·2	37·8	42·6	32·3	31·6	10·3	37·2	33·5	·193	2·3	0·4	88	540	61·6	29·0	1·0	5	8	9	9	—	7·6	51	7·78
Hull - - -	29·680	56·0	23·0	33·0	44·6	32·7	30·3	11·9	39·1	34·5	·200	2·4	0·5	84	554	55·4	31·4	1·3	3	8	10	11	—	6·7	51	6·05
Stonyhurst - - -	29·627	56·9	19·1	37·8	44·8	33·1	32·9	12·7	38·4	34·3	·199	2·3	0·4	86	548	73·4	28·9	—	5	8	8	10	—	8·1	55	10·39
Bradford - - -	29·615	58·0	24·0	34·0	44·6	34·5	28·0	10·1	39·1	34·6	·201	2·3	0·5	85	547	50·8	—	0·7	7	7	7	7	—	8·2	68	6·05
Leeds - - -	29·629	60·0	25·0	35·0	45·1	35·9	29·7	9·2	40·1	35·7	·210	2·4	0·5	85	550	—	—	1·2	6	6	9	9	—	7·5	52	4·74
Lancaster - - -	29·604	56·0	23·5	32·5	44·9	34·2	28·8	10·6	39·6	36·0	·212	2·5	0·3	88	551	—	—	—	4	6	15	6	—	—	53	9·78
Silloth - - -	29·572	53·2	21·8	31·4	44·8	34·4	28·1	10·4	39·2	35·6	·208	2·4	0·4	87	553	77·7	29·3	1·7	4	10	7	9	9·4	6·4	50	8·37
Carlisle - - -	29·576	57·8	20·0	37·8	45·6	32·4	34·2	13·2	38·9	34·4	·199	2·3	0·5	84	551	61·0	27·9	0·9	2	10	5	12	2·6	8·3	39	5·66

The highest temperatures of the air were at Salisbury, 65°·0; at Camden Square, 62°·6; at Barnet and Cardington, 61°·2.
The lowest temperatures of the air were at Salisbury, 18°·0; at Rugby, 19°·0; at Barnet and Stonyhurst, 19°·1.
The greatest ranges of temperature were at Salisbury, 16°·1; at Barnet, 14°·6; at Cambridge, 14°·0.
The least ranges of temperature were at Guernsey, 7°·7; at Ventnor, 8°·2; at Liverpool, 8°·4.
The greatest number of days of rain were at Bradford, 68; at Nottingham, 67; at Guernsey, 63.
The least number of days of rain were at Cardington, 32; at Barnet and Holkham, 34.
The greatest falls of rain were at Totnes, 11·28 inches; at Bolton, 11·24 inches; at Bath, 10·65 inches.
The least falls of rain were at Cambridge, 4·03 inches; at Cardington, 4·24 inches; at Lowestoft, 4·36 inches.

QUARTERLY METEOROLOGICAL TABLE for different PARALLELS of LATITUDE.

PARALLELS OF LATITUDE, &c.	Mean Pressure of dry Air reduced to the level of the Sea.	Mean of all Highest Readings of the Thermometer.	Mean of all Lowest Readings of the Thermometer.	Mean Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	WIND. Mean Estimated Strength.	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	RAIN. Mean Number of Days it fell.	Mean Amount collected.
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
Guernsey - - - -	29·662	54·0	27·4	26·6	47·0	39·4	21·4	7·7	42·7	38·8	·237	2·7	0·4	88	544	77·7	38·8	1·1	5	8	12	5	3·2	7·0	63	9·92
Between the latitudes 50° and 51° -	29·659	57·3	26·7	30·6	47·5	37·2	26·8	10·3	42·0	38·1	·231	2·7	0·5	86	550	78·3	32·4	0·7	6	7	9	8	5·3	6·8	47	8·04
51° and 52° -	29·675	60·4	22·5	37·9	46·6	34·2	33·0	12·4	41·4	36·4	·217	2·5	0·4	87	550	72·9	29·4	1·4	6	7	10	8	2·3	6·6	44	6·89
52° and 53° -	29·631	58·0	22·6	35·4	45·2	33·4	30·4	11·8	40·0	35·3	·210	2·4	0·4	88	551	63·0	29·3	1·1	5	6	12	7	3·2	6·8	45	5·12
53° and 54° -	29·622	57·4	23·3	34·1	44·5	34·2	28·8	10·3	39·2	34·9	·204	2·4	0·5	86	548	57·8	40·8	1·1	5	7	10	9	—	7·4	54	7·62
54° and 55° -	29·574	55·5	20·9	34·6	45·2	33·4	31·2	11·8	39·1	35·0	·204	2·3	0·4	86	552	69·3	28·6	1·3	3	10	6	10	6·0	7·4	45	7·08
Mean for the Quarter, 50° to 55° Year 1882	29·907	60·6	25·6	35·0	48·9	37·6	29·7	11·3	45·1	39·4	·243	2·8	0·4	87	554	71·9	32·7	1·2	3	4	10	14	3·6	7·1	41	6·55
„ 1883	29·699	56·5	19·6	36·9	45·9	34·1	29·4	11·8	39·4	36·0	·214	2·5	0·4	85	552	74·0	29·8	1·3	5	7	8	10	4·2	6·4	48	6·99
„ 1884	29·668	65·8	26·6	39·2	48·4	37·6	29·6	10·8	42·8	39·0	·238	2·7	0·4	87	548	71·1	33·2	1·4	8	6	10	11	4·2	7·4	58	8·56
„ 1885	29·636	57·7	23·2	34·5	45·8	34·5	30·0	11·3	40·3	35·9	·213	2·5	0·4	87	550	68·3	33·0	1·1	5	7	9	8	4·2	7·0	47	6·94

METEOROLOGY OF ENGLAND,

DURING THE QUARTER ENDING JUNE 30, 1885.

REMARKS ON THE WEATHER DURING THE QUARTER ENDING JUNE 30TH, 1885.

By JAMES GLAISHER, ESQ., F.R.S., *&c.*

The weather in April was cold till after the middle, and warm from the 17th to the end of the month, the barometer readings were generally low throughout the month, the average pressure being reached or exceeded on nine days only. The direction of the wind during the first half of the month was E. and N.W. and it was chiefly S.W. from the 17th. The rainfall was about its average; snow fell on four different days.

The weather in May was cold throughout the month. The atmospheric pressure was variable. for a few days together above its average, and then a few days below. There was an excess of N.W. winds: snow fell on six different days within the first ten days of the month.

The weather in June was dry, the temperature very variable; it was warm till the 8th; then cold for three days, and warm on the 12th, 13th, and 14th, after which it was mostly cold. The atmospheric pressure was variable throughout the month; the East wind was prevalent. During the last week or ten days the weather was favourable for haymaking; vegetation was backward but generally luxuriant.

About London the mean daily temperature of the air was for the first day in April above its average by 3°·3; it was below from the 2nd to the 16th, the average daily deficiency being 3°·6; from the 17th to the end of the month the temperature was much higher, being 5°·1 above the daily average; it was below from May 1st to the 26th, the average deficiency being 4°·8. From May 27th to June 8th the average daily excess of mean temperature was 4°·3; for three days there was a mean deficiency of 5°·5 daily, then three days of a mean excess of 3°·4 daily, and from June 15th to the end of the quarter the deficiency averaged 3°·0 daily.

The mean temperature of the air for April was 47°·7, being 1°·6 and 0°·7 above the averages of 114 years and 44 years respectively; it was 2°·6, and 0°·9 higher than in 1884 and 1883, respectively; and 0°·2 lower than in 1882.

The mean temperature of the air for May was 49°·9, being 2°·6 and 2°·8 below the averages of 114 years and 44 years respectively; it was 4°·4, 3°·2, and 4°·6 lower than in 1884, 1883, and 1882 respectively. Back to 1879 when it was 48·4, there has been no instance of so low a temperature as 49°·9 in May.

The mean temperature of the air for June was 59°·5, being 1°·3 and 0°·6 above the averages of 114 years and 44 years respectively; it was 1°·5, 0°·5, and 3°·0, higher than in 1884, 1883, and 1882 respectively.

The mean temperature of the quarter was 52°·4, being 0°·1 above the averages of 114 years and 0°·5 below the average of 44 years.

The mean high day temperature of the air in April was 57°·7, being 0°·2 above the average of 44 years; in May it was 60°·3, being 4°·0 below the average of 44 years; and in June it was 70°·9, being 0°·1 above the average of 44 years.

The mean low night temperature of the air in April was 38°·9, being 0°·2 below the average of 44 years; in May it was 41°·3, being 2°·4 below the average of 44 years; and in June it was 49°·2, being 0°·7 below the average of 44 years.

The mean daily range of temperature in April was 18°·8, being 0°·4 above the average; in May it was 19°·0, being 1°·5 below the average; and in June it was 21°·7, being 0·7 above the average.

The mean temperature of the air for April was 7°·4 higher than in March; in May it was 2°·2 higher than in April; and in June it was 9°·6 higher than in May.

(From the preceding 44 years' observations the increase of temperature from March to April is 5°·3, the increase from April to May is 5°·7, and the increase from May to June is 6°·2.)

From March to April there was an increase of temperature at stations south of 51° of 3°·5, between 51° and 52° of 6°·1, between 52° and 53° of 5°·8, between 53° and 54° of 5°·3, and north of 54° of 5°·1.

From April to May there was an increase of temperature at stations south of 51° of 2°·9, between 51° and 52° of 2°·3, between 52° and 53° of 1°·7, between 53° and 54° of 1°·9, and north of 54° of 1°·8.

From May to June there was an increase of temperature at stations south of 51° of 8°·1, between 51° and 52° of 9°·2, between 52° and 53° of 9°·3, between 53° and 54° of 7°·9, and north of 54° of 8°·1.

The mean reading of the barometer for the month of April at the height of 159 ft. above the level of the sea was 29·616 ins., being 0·133 in. below the average of 44 years, and 0·029 in. and 0·210 in. lower than in 1884 and 1883 respectively, and 0·014 in. higher than in 1882.

The mean reading of the barometer for the month of May was 29·628 ins., being 0·164 in. below the average of 44 years, and 0·196 in., 0·156 in., and 0·247 in. lower than in 1884, 1883, and 1882 respectively. Back to 1841 there has been only one instance, viz., that in 1878 when it was 29·618 ins., of so low a reading as 29·628 ins.

1885. MONTHS.	Temperature of Air. Mean.	Air. Diff. from average of 114 years.	Air. Diff. from average of 44 years.	Evaporation. Mean.	Evaporation. Diff. from average of 44 years.	Dew Point. Mean.	Dew Point. Diff. from average of 44 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 44 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 44 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 44 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	grs.
April -	47·7	+1·6	+0·7	44·3	+0·4	40·5	0·0	18·8	+0·4	·252	−0·001	2·9	0·0
May -	49·9	−2·6	−2·8	46·2	−2·7	42·2	−2·9	19·0	−1·5	·269	−0·030	3·0	−0·4
June -	59·5	+1·3	+0·6	54·6	+0·1	50·4	−0·3	21·7	+0·7	·366	−0·004	4·1	−0·1
Means -	52·4	+0·1	−0·5	48·4	−0 7	44·4	−1·1	19·8	−0·1	·296	−0·012	3·3	−0·2

1885. MONTHS.	Degree of Humidity. Mean.	Humidity. Diff. from average of 44 years.	Reading of Barometer. Mean.	Barometer. Diff. from average of 44 years.	Weight of a Cubic Foot of Air. Mean.	Weight. Diff. from average of 44 years.	Rain. Amount.	Rain. Diff. from average of 70 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
April -	77	− 3	29·616	−0·133	541	− 2	2·05	+0·31	298	10	17	3	22·9	43·8
May -	76	− 3	29·628	−0·164	538	− 2	2·10	+0·05	282	8	16	7	23·2	50 3
June -	73	− 2	29·857	+0·052	532	0	1·67	−0·33	271	0	11	16	30·1	51·3
Means	75	− 3	29·700	−0·082	537	− 1	Sum 5·82	Sum +0·01	Mean 283	Sum 18	Sum 47	Sum 26	Lowest 22·9	Highest 51·3

NOTE.—In reading this table it will be borne in mind that the plus sign (+) signifies *above* the average, and the minus sign (−) signifies *below* the average.

Average duration of the different directions of the wind referred to eight points of the compass, and duration of each direction in each month in the quarter, were as follows:—

Direction of Wind.	APRIL. 1885.	APRIL. Average.	APRIL. Departure from Average.	MAY. 1885.	MAY. Average.	MAY. Departure from Average.	JUNE. 1885.	JUNE. Average.	JUNE. Departure from Average.
	d.	d.	d.	d.	d.	d.	d.	d.	d.
N.W.	3¾	2½	+ 1¼	6	1¾	+4¼	2¾	2½	+ ¼
N.	2	4¼	− 2¼	0	4¼	−4¼	1¾	3¼	−1½
N.E.	6	6¼	− ¼	1	7¼	−6¼	1¼	3½	−2¼
E.	7¼	3¾	+ 3½	2½	2¼	+ ¼	11¾	2¼	+9½
S.E.	2	2¼	− ¼	2¼	1¾	+ ½	¼	1¾	−1½
S.	1¼	2½	− 1¼	4	2¾	+1¼	1¼	2¼	−1
S.W.	6½	6½	0	11½	8¾	−3¼	8¾	10	−1¼
W.	1½	2¾	− 1¼	3¼	2¾	+ ½	2½	4	−1½
Calm.	0	0	0	0	0	0	0	0	0

The plus sign (+) denotes excesses over averages; the largest numbers affected with this sign in the month of April are opposite to E. and N.W.; in May to N.W. and S.; and in June to E. and N.W.

The minus sign (−) denotes deficiencies below averages. In April the largest numbers are opposite to N., S., and W.; in May to N.E. and N.; and in June to N.E. and W.

The mean reading of the barometer for the month of June was 29·857 ins., being 0·052 in. above the average of 44 years, and the same as in 1884, 0·064 in. and 0·122 in. respectively higher than in 1883 and 1882. Back to 1841 there have been but fifteen instances of readings exceeding 29·857 ins.

In 1842 - 29·901 inches.	1855 - 29·863 inches.	1867 - 29·935 inches.
1846 - 29·866 „	1856 - 29·877 „	1868 - 29·980 „
1849 - 29·868 „	1857 - 29·858 „	1869 - 29·920 „
1850 - 29·886 „	1858 - 29·915 „	1870 - 29·947 „
1851 - 29·895 „	1865 - 30·029 „	1874 - 29·939 „

From March to April there was a decrease of pressure at stations south of 51° of 0·292 in., between 51° and 52° of 0·284 in., between 52° and 53°, of 0·263 in., between 53° and 54° of 0·264 in., and north of 54° of 0·266 in.

From April to May there was an increase of pressure at stations south of 51° of 0·036 in., between 51° and 52° of 0·018 in., a decrease between 52° and 53° of 0·015 in., between 53° and 54° of 0·035 in., and north of 54° of 0·044 in.

From May to June there was an increase of pressure at stations south of 51° of 0·208 in., between 51° and 52° of 0·226 in., between 52° and 53° of 0·258 in., between 53° and 54° of 0·279 in., and north of 54° of 0·289 in.

About London the barometric pressure was on the first day of April below its average by 0·11 in., for the next three days the excess daily was 0·14 in.; from the 5th to the 16th there was a daily deficiency averaging 0·25 in.; from the 17th to the 21st the average daily excess equalled 0·23 in.; for 16 days, viz., from April 22nd to May 7th there was a deficiency of 0·32 in. below the average values; for five days there was a slight excess and then five days of a slight deficiency of pressure. May 18th and 19th were nearly of the average. From May 20th to the 23rd the readings of the barometer were low, being 0·44 in. below their daily averages. From May 24th to June 3rd there was a slight excess of 0·09 in. daily; from the 4th to the 8th there was a deficiency, being 0·11 in. below the average; from the 9th to the 16th there was an excess of pressure, being 0·21 in. above the average, for the next four days a daily deficiency of 0·16 in., and from June 21st to the end of the quarter there was a slight excess of 0·06 in. daily.

Thunderstorms occurred in April on the 26th at Burslem, Liverpool, Bolton, Halifax, Stonyhurst, and Carlisle.

In May on the 2nd at Nottingham and Silloth; on the 4th at Plymouth; on the 6th at Torquay and Barnet; on the 7th at Hull; on the 9th at Barnet; on the 11th at Liverpool; on the 14th at Wolverhampton and Bradford; on the 16th at Bedford, Lowestoft, and Burslem; on the 17th at Southbourne, Marlborough, Whitchurch, Barnet, Oxford, Cardington, Cambridge, Leicester, and Nottingham; on the 20th at Leeds; on the 21st at Royston, Cambridge, Wolverhampton, Leicester, Bolton, Hull, and Leeds; on the 22nd at Oxford, Nottingham, and Stonyhurst; on the 23rd at Royston, Halifax, and Hull; and on the 29th at Bolton.

In June on the 4th and 5th at Guernsey; on the 6th at Ventnor; on the 7th at Southbourne, Rodmersham, Burslem, Halifax, Hull, and Stonyhurst; on the 8th at Hull; and on the 14th at Guernsey.

Thunder was heard but lightning was not seen in April, on the 6th at Bedford; on the 23rd at Somerleyton; on the 25th at Cambridge; on the 26th at Lancaster; and on the 27th at Wolverhampton and Halifax.

In May on the 2nd at Cambridge; on the 3rd at Whitchurch and Wolverhampton; on the 4th at Truro, and Royston; on the 6th at Osborne, Rodmersham, and Lowestoft; on the 9th at Hull; on the 10th at Halifax; on the 13th at Nottingham; on the 14th at Osborne and Halifax; on the 16th at Bath, Whitchurch, Rugby, Lowestoft, and Somerleyton; on the 17th at Ventnor, Bath, Rodmersham, Marlborough, and Royston; on the 19th at Camden Square; on the 21st at Camden Square and Cardington; on the 22nd at Plymouth and Whitchurch; on the 23rd at Rodmersham, Rugby and Somerleyton; on the 24th at Rugby and Somerleyton; and on the 26th at Halifax.

In June on the 6th at Cambridge.

Lightning was seen but thunder was not heard in May, on the 4th at Blackheath; on the 6th at Torquay; on the 7th at Rodmersham; on the 16th at Lowestoft and Somerleyton; and on the 17th at Ventnor.

In June on the 4th at Plymouth; on the 7th at Cambridge; and on the 14th at Torquay.

Solar halos were seen in April on the 2nd at Torquay; on the 3rd at Halifax; on the 7th at Torquay and Rodmersham; on the 9th at Torquay; on the 15th at Rodmersham; on the 20th and 26th at Halifax; and on the 26th at Torquay.

In May on the 8th and 12th at Torquay; on the 13th at Torquay, Bath, Rodmersham, Oxford, Royston, and Stonyhurst; on the 20th at Oxford; on the 22nd at Stonyhurst; and on the 28th and 30th at Rodmersham.

In June on the 5th at Oxford; on the 7th at Bath; on the 10th and 11th at Oxford and Halifax; on the 29th at Torquay.

Lunar halos were seen in April on the 1st and 23rd at Torquay; on the 26th at Oxford and Hull; on the 27th at Oxford, Burslem, and Hull; and on the 28th at Halifax.

In May on the 24th at Torquay and Bath; and on the 26th at Oxford.

Aurora Borealis was seen in May on the 14th at Stonyhurst.

Snow fell in April on the 1st at Torquay, Bath, and Marlborough; on the 2nd at Bolton; on the 16th at Burslem and Liverpool; and on the 26th at Bolton.

In May on the 4th at Silloth; on the 6th at Marlborough and Leicester; on the 7th at Bath, Rodmersham, Wolverhampton, Nottingham, Burslem, Bolton, Halifax, Hull, and Leeds; on the 8th at Barnet, Burslem, and Bolton; and on the 9th and 10th at Burslem and Bolton.

Hail fell in April, on the 6th at Torquay, Bath, Oxford, Royston, and Cambridge; on the 7th and 16th at Torquay; on the 25th at Rodmersham and Royston; on the 26th at Leicester, Burslem, Bolton, and Bradford; on the 27th at Hull; and on the 30th at Totnes.

In May on the 2nd at Torquay, Cardington, and Cambridge; on the 3rd at Oxford and Royston; on the 5th at Silloth; on the 6th at Torquay, Rodmersham, Barnet, and Silloth; on the 7th at Marlborough, Barnet, Oxford, Cambridge, Burslem, Bolton, Halifax, and Silloth; on the 8th at Plymouth, Osborne, Barnet, Oxford, Royston, Cambridge, Burslem, Llandudno, Liverpool, and Bolton; on the 9th at Marlborough, Royston, Cambridge, Wolverhampton, Burslem, Llandudno, Bolton, and Halifax; on the 10th at Burslem, Llandudno, Liverpool, and Halifax; on the 11th at Somerleyton, Nottingham, and Liverpool; on the 14th at Torquay, Cardington, Wolverhampton,

(*continued on page* 71.)

MONTHLY METEOROLOGICAL TABLE FOR THE QUARTER ENDING JUNE 30TH, 1885.

The Observations have been reduced to Mean values by Glaisher's Barometrical and Diurnal Range Tables, and the Hygrometrical results have been deduced from the sixth edition of his Hygrometrical Tables.

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1885.	Pressure of Atmosphere in Month.		Temperature of Air in Month.						Mean Temperature.		Vapour.			Mean Degree of Humidity, Sat.=100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer.		Wind.					Mean Amount of Ozone.	Mean Amount of Cloud.	Rain.	
								Mean						In a cubic foot of Air.							Relative Proportion of							
		Months.	Mean.	Range.	Highest.	Lowest.	Range.	Of all Highest.	Of all Lowest.	Daily Range.	Air.	Dew Point.	Elastic Force.	Mean.	Short of Saturation.			Maximum in Rays of Sun.	Minimum on Grass.	Estimated Strength.	N.	E.	S.	W.			Number of Days it fell.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
GUERNSEY, Adolphus Collenette, Esq., F. R. Met. Soc.	270	April	29·504	1·100	68·8	35·0	33·8	52·8	41·9	10·9	46·3	40·8	·256	2·9	0·7	82	540	104·9	33·9	1·0	10	5	8	6	2·6	4·5	19	1·84
		May	29·581	0·860	65·8	36·6	29·2	55·8	43·7	12·1	48·9	43·3	·281	3·4	0·8	81	539	109·8	37·3	1·1	3	2	6	20	3·3	6·2	23	2·22
		June	29·756	0·651	77·0	42·7	34·3	63·6	51·5	12·1	56·1	50·1	·363	4·1	0·9	80	534	118·6	46·9	0·9	10	9	3	8	2·9	5·5	10	0·99
TRURO (Cornwall), N. Whitley, Esq., F. R. Met. Soc.	43	April	29·668	1·210	67·0	28·0	39·0	55·2	37·9	17·3	44·7	39·5	·242	2·8	0·5	82	545	—	—	2·7	10	7	8	5	—	5·6	15	3·51
		May	29·705	0·890	62·0	32·0	30·0	57·4	43·0	14·4	47·7	39·2	·240	2·7	1·0	78	542	—	—	2·8	8	2	7	14	—	6·7	18	3·08
		June	29·888	0·650	79·0	42·0	37·0	66·8	50·4	16·4	55·9	49·3	·352	3·9	1·1	79	536	—	—	2·4	8	7	10	5	—	6·1	8	2·26
PLYMOUTH (Devon), J. Merrifield, Esq. LL.D., F.R.A.S., F. R. Met. Soc.	69	April	29·725	1·161	65·0	31·0	34·0	53·8	39·7	13·6	45·8	39·6	·245	2·7	0·7	79	545	—	—	1·2	8	9	6	7	—	5·4	15	3·28
		May	29·766	0·839	62·5	33·5	29·0	56·8	43·5	13·3	49·1	44·7	·297	3·4	0·6	85	542	—	—	1·5	5	4	7	15	—	6·9	25	3·55
		June	29·950	0·710	75·5	45·0	30·5	65·6	52·0	13·6	57·8	50·6	·368	4·1	1·2	85	535	—	—	1·3	7	9	9	5	—	5·7	11	1·95
TOTNES (Devon), T. H. Edmonds, Esq.	107	April	29·724	1·166	70·2	26·9	43·3	55·3	36·7	18·6	45·9	38·5	·235	2·7	0·8	77	545	—	—	2·9	14	4	8	4	—	5·5	15	4·31
		May	29·760	0·894	66·8	29·7	37·1	58·4	40·5	17·9	48·9	42·5	·273	3·0	1·0	80	542	—	—	2·3	4	4	6	17	—	6·5	24	3·66
		June	29·968	0·732	77·8	33·8	39·0	67·5	48·7	18·8	57·5	49·9	·359	4·0	1·3	76	536	—	—	1·7	7	10	6	7	—	5·5	12	1·81
TORQUAY, Babbacombe (Devon), Edwin E. Glyde, Esq., F. R. Met. Soc.	305	April	29·459	1·277	68·7	31·5	37·2	58·2	40·0	18·2	45·7	38·4	·233	2·7	0·8	76	542	106·0	32·0	1·5	9	7	6	8	5·4	5·7	18	3·54
		May	29·507	1·080	65·6	35·0	30·6	55·5	42·2	13·3	48·1	41·3	·260	2·9	0·9	77	538	113·7	35·0	1·3	4	4	8	15	6·0	6·7	23	3·67
		June	29·728	0·765	72·7	43·5	29·2	64·3	51·4	12·9	57·2	50·2	·363	4·0	1·1	78	532	118·0	46·0	1·2	8	10	6	6	4·5	5·9	11	1·02
VENTNOR, (Isle of Wight) (Royal National Hospital for Consumption), Hartley Sagar, Esq.	80	April	29·674	1·106	69·4	32·1	37·3	55·0	42·0	13·0	47·0	39·3	·241	2·8	0·9	75	542	—	—	0·9	6	11	4	9	5·7	5·1	12	0·91
		May	29·680	1·062	64·3	38·1	26·2	56·6	44·2	12·4	49·0	44·4	·294	3·2	0·7	85	542	—	—	1·1	4	8	8	16	5·6	6·3	18	2·21
		June	29·915	0·649	74·6	45·7	28·9	64·8	52·5	12·3	56·4	50·4	·367	4·0	1·0	81	536	—	—	1·0	7	11	4	8	—	5·5	10	2·57
OSBORNE (Isle of Wight), J. R. Mann, Esq.	172	April	29·606	1·104	71·2	26·7	44·5	58·1	38·6	19·5	45·4	42·1	·258	3·0	0·5	86	548	109·2	37·0	0·1	10	7	8	5	—	4·7	11	1·04
		May	29·650	1·008	68·6	33·1	35·5	59·3	41·4	17·9	49·3	45·8	·306	3·5	0·6	88	539	110·1	40·3	0·2	6	1	12	12	—	6·1	19	3·62
		June	29·852	0·772	81·2	42·2	39·0	68·6	49·9	18·7	57·2	53·4	·409	4·6	0·6	87	534	115·0	49·1	0·1	8	9	6	7	—	5·8	11	1·32
SOUTHBOURNE, (near) Bournemouth (Hants), T. A. Compton, Esq., M.D., B.A., F. R. Met. Soc.	95	April	29·671	1·124	67·5	25·9	41·6	54·1	38·6	15·5	45·8	38·4	·232	2·7	0·8	77	544	—	—	1·6	13	5	9	3	—	4·3	11	1·00
		May	29·684	0·950	61·3	32·7	28·6	56·0	42·0	14·0	48·1	41·4	·260	2·9	0·9	77	541	—	—	1·5	7	2	8	14	—	5·0	17	3·57
		June	29·910	0·726	73·5	44·0	29·5	64·3	50·6	13·7	56·2	49·6	·357	3·9	1·1	79	537	—	—	1·5	8	9	7	6	—	5·6	12	2·52
SALISBURY (Wilton House), Wilts, Thomas Challis, Esq.	186	April	29·591	1·092	74·0	20·0	54·0	58·5	34·4	24·1	—	—	—	—	—	—	—	108·0	32·3	1·1	9	10	6	5	—	5·7	22	2·21
		May	29·621	0·962	68·0	27·0	41·0	61·1	36·3	24·8	—	—	—	—	—	—	—	108·6	34·6	1·0	10	3	7	11	—	6·5	22	3·28
		June	29·826	0·752	83·0	35·0	48·0	71·7	45·2	26·5	57·5	51·2	·377	4·3	1·1	70	533	115·3	44·5	1·1	8	6	8	8	—	5·8	16	1·67
BARNSTAPLE (Devon), William Knill, Esq.	43	April	29·757	1·150	72·0	33·0	39·0	56·4	42·0	13·5	48·2	41·5	·261	3·0	0·9	78	542	—	—	1·4	10	8	7	5	—	2·7	12	2·44
		May	29·718	0·870	69·0	41·0	28·0	59·5	46·3	13·2	51·2	45·5	·305	3·5	0·8	81	540	—	—	1·2	4	1	11	15	—	4·7	17	3·31
		June	30·012	0·780	83·5	45·0	38·5	70·3	56·2	14·1	61·4	52·5	·395	4·3	1·7	73	533	—	—	1·2	6	7	8	9	—	2·5	10	3·62

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1885. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean. Of all Highest.	Mean. Of all Lowest.	Mean. Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a Cubic foot of Air. Mean.	Vapour. In a Cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
BATH (Somerset), St. Gregory's College, Downside, Rev. T. J. Almond, O.S.B.	596	April	29.135	1.115	69.8	27.4	42.4	52.5	37.2	15.3	43.8	37.0	.220	2.5	0.7	76	546	104.8	25.5	1.8	10	7	6	7	—	5.3	12	3.61
		May	29.162	0.896	60.8	34.0	26.8	53.9	40.3	13.6	45.9	40.4	.252	2.9	0.7	83	534	112.2	28.4	1.4	6	2	8	15	—	6.6	24	3.69
		June	29.402	0.877	76.9	38.5	38.4	65.0	49.1	15.9	55.8	49.2	.352	3.9	1.1	79	528	119.0	36.2	1.6	12	4	7	7	—	5.8	11	1.38
RODMERSHAM, near Sittingbourne (Kent), R. M. Mercer, Esq., F.R. Met. Soc.	140	Jan.	—	—	52.5	21.8	30.7	40.0	32.1	7.9	36.8	34.2	.197	2.2	0.4	81	—	56.9	25.4	1.5	6	7	11	8	—	7.2	20	2.48
		Feb.	—	—	55.5	30.3	25.2	48.4	39.1	9.3	43.8	39.8	.244	2.8	0.5	87	—	78.1	33.3	2.3	—	—	—	—	6.3	6.4	18	2.94
		Mar.	—	—	58.8	28.1	30.7	46.5	33.5	13.0	39.7	34.4	.200	2.3	0.5	81	—	90.7	26.9	1.2	—	—	—	—	5.9	6.2	8	1.30
		April	—	—	71.0	29.9	41.1	53.3	39.9	13.4	46.0	40.4	.252	2.9	0.7	82	—	98.2	34.5	1.7	11	5	9	5	5.3	5.3	14	1.24
		May	—	—	71.3	29.4	41.9	56.1	41.3	14.8	47.9	42.2	.268	3.0	0.8	83	—	106.1	36.9	1.7	6	4	10	11	4.2	6.1	18	2.62
		June	—	—	79.3	40.0	39.3	64.9	49.3	15.6	56.3	48.9	.317	3.9	1.2	76	—	110.2	44.3	1.4	10	4	9	7	3.3	6.1	8	0.90
MARLBOROUGH (Wilts), Rev. Thomas A. Preston, M.A., F. R. Met. Soc.	456	April	29.284	1.370	70.7	22.8	47.9	54.2	36.5	17.7	44.7	38.2	.231	2.6	0.7	78	538	106.7	29.9	0.7	7	11	5	7	—	6.2	14	2.32
		May	29.302	0.946	65.2	29.0	36.2	56.4	39.8	16.6	46.7	40.7	.255	3.0	0.6	81	536	114.8	35.0	0.6	7	4	8	12	—	6.4	22	3.05
		June	29.538	0.628	84.1	36.1	48.0	67.0	48.1	18.9	56.7	48.6	.348	3.8	1.3	74	530	120.7	45.4	0.6	7	8	6	9	—	5.5	12	1.68
BLACKHEATH (Kent), James Glaisher, Esq., F.R.S.	150	April	29.615	1.074	72.5	28.5	44.0	57.8	38.8	19.0	46.9	37.2	.242	2.8	0.9	76	542	109.7	—	0.8	7	11	5	7	—	4.5	10	2.02
		May	29.625	1.022	75.8	31.5	44.3	60.9	41.8	19.1	49.5	43.1	.279	3.2	0.9	79	539	109.4	—	0.9	3	4	11	13	—	5.5	16	2.22
		June	29.849	0.893	86.8	41.2	45.6	72.1	50.0	22.1	59.5	50.4	.367	4.1	1.2	72	532	124.5	—	1.1	3	13	6	8	—	4.3	6	1.51
ROYAL OBSERVATORY, Greenwich, W. H. M. Christie, M.A., F.R.S., Astronomer Royal.	139	April	29.616	1.073	73.6	28.1	45.5	57.7	38.9	18.8	47.7	40.5	.252	2.9	0.9	77	541	109.0	32.6	—	—	—	—	—	4.7	5.9	9	2.05
		May	29.628	1.047	74.8	31.8	43.0	60.3	41.3	19.0	49.9	42.2	.269	3.0	1.0	76	538	117.5	35.3	—	—	—	—	—	6.8	6.8	19	2.10
		June	29.857	0.860	84.7	39.4	45.3	70.9	49.2	21.7	59.5	50.4	.366	4.1	1.6	73	532	126.1	42.5	—	—	—	—	—	2.7	5.5	7	1.67
WHITCHURCH RECTORY (Oxon), (near Reading), Rev. J. Slatter, M.A., F.R. Met. Soc.	150	April	29.635	1.073	72.3	26.8	45.5	57.3	36.7	20.6	46.6	39.7	.245	2.8	0.8	78	543	—	—	1.2	10	9	4	7	—	4.3	13	1.78
		May	29.698	0.819	69.0	29.8	39.2	60.7	39.3	21.4	49.7	40.3	.231	2.8	1.0	70	540	—	—	1.6	4	5	8	14	—	6.3	21	2.15
		June	29.898	0.843	84.1	38.2	45.9	70.6	46.7	23.9	58.1	49.2	.351	3.9	1.5	72	534	—	—	1.3	6	10	6	8	—	4.3	13	1.49
CAMDEN SQUARE (London), G. J. Symons, Esq., F.R.S., F. R. Met. Soc.	123	April	29.657	1.104	72.8	29.3	43.5	58.4	39.7	18.7	47.8	39.2	.240	2.9	1.1	73	541	92.6	33.8	—	10	10	6	4	—	5.7	11	2.32
		May	29.672	1.053	73.8	31.1	42.7	59.7	42.2	17.5	49.7	41.0	.254	2.9	1.1	72	540	101.8	37.5	—	1	8	8	14	—	6.0	19	2.63
		June	29.800	0.850	84.7	41.4	43.3	70.9	50.7	20.2	59.1	43.3	.330	3.8	1.8	67	523	106.4	47.2	—	7	8	7	8	—	4.9	11	1.99
BARNET (Gas Works), T. H. Martin, Esq., C.E.	213	April	29.599	1.091	72.2	23.0	49.2	57.6	35.2	22.4	43.6	38.9	.238	2.7	0.8	78	543	109.2	30.9	0.9	5	12	5	8	—	5.4	10	2.37
		May	29.595	1.005	73.2	27.3	45.9	59.4	38.6	20.8	47.8	40.7	.234	2.9	0.8	77	540	121.1	36.0	1.0	8	5	4	14	—	6.0	16	2.40
		June	29.834	0.859	84.9	35.2	49.7	69.3	48.2	21.1	56.7	48.8	.316	3.9	1.2	75	534	125.7	44.3	1.0	8	9	3	10	—	5.0	8	2.31
OXFORD (The Observatory), E. J. Stone, Esq., M.A., F.R.S.	210	April	29.575	1.116	69.8	27.1	42.7	55.5	39.1	16.4	47.1	39.8	.216	2.8	0.9	76	540	104.2	32.2	2.8	11	6	7	6	4.5	5.7	12	1.72
		May	29.578	0.966	65.5	32.4	33.1	56.9	41.5	15.4	49.0	41.1	.259	2.9	1.1	74	539	108.8	35.1	2.8	5	3	10	13	4.8	6.2	20	2.18
		June	29.812	0.848	80.6	39.6	41.0	67.9	49.4	18.5	58.7	50.0	.300	3.0	1.3	72	532	116.2	44.4	2.7	10	7	6	7	4.7	5.5	12	1.57
ROYSTON (Hertfordshire), Hale Wortham, Esq., F.R.A.S., F. R. Met. Soc.	269	April	29.581	1.088	74.4	23.1	51.3	57.6	37.2	20.4	43.7	40.1	.247	2.8	0.7	82	541	—	—	—	11	7	8	4	—	5.5	16	2.12
		May	29.587	0.962	73.3	32.1	41.2	59.5	39.7	19.8	47.3	43.0	.278	3.3	0.5	86	539	—	—	—	7	3	9	12	—	6.0	15	2.76
		June	29.779	0.907	85.4	36.0	49.4	71.1	48.4	22.7	57.0	52.2	.391	4.3	0.9	81	533	—	—	—	10	6	6	8	—	5.6	11	2.27
BEDFORD, Cardington, Mr. J. McLaren, Assistant to S. Whitbread, Esq., M.P.	105	April	29.688	1.114	73.2	22.0	51.2	57.4	37.6	19.8	46.4	38.2	.233	2.7	1.0	75	544	87.3	33.8	0.8	9	8	7	6	—	5.6	—	—
		May	29.687	0.986	72.0	30.0	42.0	60.0	39.0	21.0	48.3	41.2	.259	2.9	1.0	76	541	96.5	36.5	1.0	7	4	5	15	—	6.2	18	2.35
		June	29.985	0.898	86.4	35.4	51.0	70.8	47.7	23.1	58.0	47.7	.332	3.9	1.5	73	535	110.3	45.9	1.1	9	6	7	8	—	4.9	9	1.88
CAMBRIDGE (Trinity College), J. W. L. Glaisher, Esq., M.A., F.R.S.	40	April	29.782	0.952	74.0	22.7	51.3	57.9	36.9	21.0	46.1	40.3	.251	2.9	0.7	80	545	113.6	32.8	1.3	8	8	6	8	—	6.1	15	1.75
		May	29.724	0.954	74.6	30.2	44.4	60.0	39.9	20.1	48.2	42.6	.272	3.2	0.7	81	542	130.6	34.5	1.2	7	8	6	15	—	6.9	17	3.08
		June	29.971	0.906	86.7	35.3	51.4	70.5	47.8	22.7	57.8	50.2	.364	4.0	1.3	76	536	138.0	44.6	1.2	6	8	4	12	—	5.1	10	2.44
RUGBY (Warwickshire), Stockton, The Rectory, Rev. W. Tuckwell.	289	April	29.509	1.496	71.4	21.2	50.2	55.3	34.5	20.8	44.4	39.2	.240	2.8	0.6	86	542	—	—	0.6	11	8	7	4	—	6.7	14	2.30
		May																										—
		June	29.701	0.854	84.5	34.0	50.5	69.5	46.2	23.3	56.6	49.7	.357	4.0	1.1	77	532	—	—	0.5	8	9	7	6	—	5.7	9	1.92

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1885. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean. Of all Highest.	Temperature of Air in Month. Mean. Of all Lowest.	Temperature of Air in Month. Mean. Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Sat^n. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	Wind. Relative Proportion of E.	Wind. Relative Proportion of S.	Wind. Relative Proportion of W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs	°	°									in.
LOWESTOFT (Suffolk), S. H. Miller, Esq., F.R.A.S., F. R. Met. Soc.	89	April	29·687	1·020	72·5	34·5	38·0	51·8	40·5	11·3	46·6	36·5	·216	2·4	1·2	69	544	100·5	35·3	2·0	9	9	6	7	—	5·0	12	1·50
		May	29·666	0·864	64·0	31·9	32·1	54·8	41·1	13·7	47·4	41·7	·264	3·0	0·7	82	542	109·2	38·7	1·8	4	4	9	14	—	6·3	20	2·17
		June	29·921	0·960	73·8	39·3	34·5	62·9	49·5	13·4	55·3	49·2	·351	4·0	1·0	79	538	112·7	47·5	2·3	8	7	7	8	—	5·2	8	0·73
SOMERLEYTON (Suffolk), The Rectory, Rev. C. J. Steward, F. R. Met. Soc.	50	April	29·726	1·006	72·4	28·5	43·9	53·5	39·2	14·3	45·3	39·7	·244	2·8	0·7	81	546	—	—	1·0	7	11	5	7	7·2	4·3	11	1·66
		May	29·706	0·864	74·3	29·8	44·5	56·1	40·2	15·9	46·5	42·1	·269	3·1	0·5	85	544	—	—	1·0	6	3	9	13	7·2	6·4	21	3·19
		June	29·967	0·920	81·7	38·2	43·5	64·9	49·2	15·7	54·7	48·5	·343	3·8	1·1	85	538	—	—	1·0	7	7	8	8	6·7	4·7	9	0·63
WOLVERHAMPTON (Staffordshire), Wrottesley, E. Simpson, Esq.	500	April	29·281	1·124	69·5	23·7	45·8	53·1	35·5	17·6	43·1	34·8	·202	2·4	0·8	72	540	—	—	—	9	8	5	8	—	6·9	14	2·00
		May	29·273	0·874	66·5	29·0	37·5	55·3	38·2	17·1	45·6	36·1	·214	2·4	1·0	70	537	—	—	—	6	6	8	11	—	7·4	20	2·06
		June	29·587	0·914	82·1	38·0	44·1	65·9	47·7	18·2	55·3	45·8	·308	3·5	1·5	70	531	—	—	—	8	7	6	9	—	5·8	11	2·67
LEICESTER (Town Museum), J. C. Smith, Esq.	238	April	29·517	1·118	71·5	25·5	46·0	55·7	38·5	17·2	46·4	37·4	·225	2·7	0·9	72	540	94·1	29·2	0·7	10	8	6	6	—	5·5	16	2·33
		May	29·504	0·906	71·7	31·7	40·0	57·4	40·2	17·2	48·0	37·1	·220	2·5	1·3	66	539	109·0	36·0	0·7	6	3	8	14	—	6·9	20	2·49
		June	29·767	0·960	84·5	39·2	45·3	69·3	49·6	19·7	58·0	47·7	·330	3·9	1·7	74	532	116·5	38·6	0·6	8	8	6	8	—	6·0	11	2·56
NOTTINGHAM (Notts), M. O. Tarbotton, Esq., C.E., F.G.S., F. R. Met. Soc.	123	April	29·643	1·113	69·8	26·1	43·7	53·7	39·3	14·4	45·6	37·0	·221	2·6	0·9	73	554	98·9	33·0	0·2	4	9	11	6	0·4	5·5	16	1·62
		May	29·619	0·887	70·0	32·0	38·0	55·9	40·9	15·0	47·1	39·9	·246	2·8	0·9	76	541	114·5	34·6	0·2	6	4	8	13	0·7	6·5	24	1·42
		June	29·890	0·970	82·6	42·2	40·4	66·8	49·9	16·9	56·8	49·4	·353	4·0	1·1	76	535	128·7	45·1	0·2	4	8	10	8	0·6	5·6	17	2·68
BURSLEM, J. E. Worth, Esq., C.E., F. R. Met. Soc.	556	April	29·167	1·180	67·0	30·7	36·3	53·3	37·8	15·5	44·0	38·1	·230	2·7	0·6	79	537	—	33·4	1·0	6	10	7	7	—	6·1	18	2·47
		May	29·162	0·808	66·2	30·7	35·5	55·1	39·4	15·7	46·1	39·1	·239	2·7	0·9	77	534	—	35·5	1·2	6	3	10	12	—	6·5	23	2·08
		June	29·485	0·940	81·0	39·6	41·4	65·6	48·3	17·3	55·6	47·2	·327	3·7	1·3	74	529	—	45·2	0·9	5	7	6	12	—	5·7	14	3·85
LLANDUDNO (Carnarvonshire), James Nicol, Esq., M.D.	100	April	29·676	1·300	61·2	32·0	29·2	51·6	40·4	11·2	45·6	37·2	·223	2·5	0·9	78	544	—	—	0·9	6	7	7	10	—	6·1	12	1·31
		May	29·648	1·010	64·5	36·8	27·7	54·4	42·6	11·8	48·6	38·0	·229	2·7	1·3	66	540	—	—	1·0	4	4	5	18	—	7·3	11	1·08
		June	29·927	1·010	74·0	45·2	28·8	61·9	49·9	12·0	55·3	47·1	·325	3·8	1·3	78	538	—	—	0·8	9	3	3	15	—	5·7	8	0·95
LIVERPOOL, The Observatory, John Hartnup, Esq., F.R.A.S.	197	April	29·551	1·256	61·9	31·3	30·6	51·8	40·3	11·5	44·8	36·6	·216	2·5	0·9	72	548	—	—	1·2	4	11	7	8	—	5·6	18	2·30
		May	29·536	0·940	64·8	37·6	27·2	54·2	42·7	11·5	47·0	38·1	·229	2·6	1·1	72	540	—	—	1·5	4	6	6	15	—	5·5	20	1·32
		June	29·816	1·000	76·6	44·4	32·2	62·9	50·6	12·3	55·2	46·8	·322	3·7	1·2	74	536	—	—	1·1	7	7	7	9	—	5·5	9	2·02
BOLTON, Sharples (Lancashire), Rev. T. Mackereth, F.R.A.S., F. R. Met. Soc.	500	April	29·238	1·184	64·1	27·2	36·9	51·7	36·7	15·0	43·3	35·4	·207	2·4	0·8	74	539	62·3	35·0	0·9	6	8	9	7	2·7	6·6	15	1·64
		May	29·212	1·142	63·7	30·6	33·1	53·0	38·8	14·2	44·7	38·4	·232	2·7	0·7	78	537	65·5	36·9	0·7	6	3	10	12	4·8	7·5	23	2·49
		June	29·490	0·982	77·5	39·2	38·3	61·8	45·1	16·7	54·1	44·7	·295	3·4	1·3	71	531	77·9	44·3	0·6	8	8	6	8	3·1	6·6	12	5·86
HALIFAX, Bermerside Observatory (Yorkshire), E. J. Crossley, Esq., F.R.A.S.	530	April	29·250	1·100	68·6	25·0	43·6	58·0	35·4	17·6	48·2	36·2	·218	2·5	0·8	81	539	86·0	30·6	1·0	6	9	7	8	—	6·4	15	2·26
		May	29·210	0·988	71·6	29·8	41·8	56·0	37·1	18·9	45·0	38·9	·237	2·7	0·7	79	536	97·7	31·2	0·9	4	5	10	12	—	6·8	21	2·49
		June	29·495	1·004	75·5	37·0	38·5	65·3	46·0	19·3	54·1	44·2	·289	3·3	1·4	69	532	102·4	41·3	0·9	4	10	6	10	—	6·5	11	4·19
HULL (Yorkshire), The People's Park, Mr. E. Peak.	6	April	29·800	1·026	69·0	24·0	45·0	53·7	40·1	13·6	45·8	39·1	·241	2·7	0·8	78	546	80·3	34·3	1·0	11	7	9	8	—	5·8	15	1·65
		May	29·786	0·852	69·0	28·0	41·0	57·2	38·1	19·1	47·1	41·4	·260	3·0	0·7	81	544	86·0	37·4	1·0	6	1	11	18	—	6·1	19	2·09
		June	30·037	0·954	81·0	37·0	44·0	64·0	46·3	17·7	58·0	48·8	·345	3·7	0·8	85	542	92·9	45·0	1·2	14	2	5	9	—	6·0	9	2·98
STONYHURST (Lancashire), Rev. S. J. Perry, F.R.S., F. R. Met. Soc., F.R.A.S.	363	April	29·398	1·212	63·3	21·1	42·2	53·5	35·6	17·9	43·9	37·2	·221	2·6	0·7	77	541	108·5	32·3	—	7	9	5	9	—	7·4	16	1·74
		May	29·360	0·981	65·7	27·2	38·5	55·7	37·2	18·5	45·5	38·8	·237	2·8	0·7	78	538	114·0	34·3	—	4	3	8	16	—	8·6	22	2·10
		June	29·647	1·017	75·0	36·4	38·6	65·5	45·5	20·0	54·1	48·0	·310	3·5	1·2	78	534	119·5	42·9	—	5	6	3	16	—	6·9	12	3·94
BRADFORD (Yorkshire), J. McLandsborough, Esq., C.E., F.G.S.	366	April	29·379	1·168	65·8	28·6	37·2	51·7	38·6	13·1	44·3	36·5	·216	2·5	0·8	74	540	64·6	—	0·7	7	10	8	5	—	7·2	13	1·84
		May	29·318	0·905	67·9	32·4	35·5	54·8	40·7	14·1	46·0	38·3	·238	2·7	0·9	75	537	75·1	—	0·8	8	4	6	13	—	7·3	21	2·39
		June	29·621	1·013	80·6	40·9	39·7	65·3	49·0	16·3	55·2	45·4	·305	3·4	1·5	70	533	86·3	—	0·6	9	3	7	11	—	6·6	12	2·79

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1885. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean Of all Highest.	Temperature of Air in Month. Mean Of all Lowest.	Temperature of Air in Month. Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Sat. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
LEEDS (Yorkshire), The Philosophical Hall, HENRY CROWTHER, Esq.	137	April	29·685	1·114	70·0	28·0	42·0	54·3	39·2	15·1	45·5	37·9	·229	2·7	0·8	75	544	—	—	1·2	7	8	8	7	—	6·8	14	1·24
		May	29·584	0·926	72·0	34·0	38·0	56·5	41·2	15·3	47·6	38·6	·236	2·7	1·0	72	540	—	—	1·5	6	3	3	14	—	6·4	22	2·16
		June	29·876	1·038	82·0	42·0	40·0	66·7	49·4	17·3	56·4	46·0	·312	3·5	1·6	68	536	—	—	1·5	8	5	6	11	—	5·9	10	2·78
LANCASTER (Southfields). WILLIAM ROPER, Esq., F.R. Met. Soc.	114	April	29·638	1·195	65·0	27·5	37·5	52·5	37·6	14·9	44·6	38·0	·230	2·6	0·7	75	545	—	—	—	—	—	—	—	—	—	14	1·61
		May	29·602	0·914	68·5	31·0	32·5	55·1	40·1	15·0	46·7	39·8	·246	2·8	0·8	78	542	—	—	—	7	4	10	10	—	—	19	2·52
		June	29·865	0·640	74·0	41·0	33·0	63·3	47·3	16·0	54·5	45·4	·304	3·4	1·4	72	538	—	—	—	4	7	5	14	—	—	11	2·04
SILLOTH (Cumberland). "The Rectory," REV. F. REDFORD, M.A., F.R.A.S., F. R. Met. Soc.	28	April	29·714	1·260	63·5	28·5	35·0	52·2	37·6	14·6	44·2	38·3	·232	2·7	0·6	80	546	99·1	32·1	1·4	2	12	6	10	10·0	5·5	9	1·94
		May	29·692	1·015	63·6	30·2	33·4	54·6	39·9	14·7	46·5	41·9	·267	3·1	0·5	85	543	104·8	35·1	1·3	5	7	6	13	8·6	6·9	20	1·71
		June	29·978	1·101	73·4	35·5	37·9	64·6	45·9	18·7	54·4	47·3	·326	3·5	1·2	77	540	113·9	43·0	1·3	4	8	4	14	7·5	5·4	12	1·36
CARLISLE, Spital (Cumberland). ISAAC CARTMEL, Esq., F. R. Met. Soc.	114	April	29·654	1·058	66·6	24·7	41·9	54·2	36·6	17·6	44·3	41·9	·266	3·1	0·3	90	545	82·2	31·3	1·0	3	10	5	12	2·9	8·3	10	1·56
		May	29·589	1·008	65·8	27·6	38·2	56·1	37·7	18·4	45·5	40·3	·250	2·9	0·6	83	543	91·1	32·4	0·8	5	4	4	18	2·8	8·4	17	1·83
		June	29·881	1·060	76·8	32·5	44·3	65·7	44·4	21·3	53·8	45·5	·304	3·4	1·3	72	539	102·8	40·0	0·7	5	4	6	15	2·3	8·0	8	0·96

Second Rain-gauges are placed—

			April.		May.		June.		Total in Quarter
At Oxford,	at the height of 22 feet *above the ground;* the amount collected was		1·70	inches. -	2·09	inches. -	1·51	inches. -	5·30 inches.
,, Cardington	,, 21 ,,	,,	—	,, -	2·21	,, -	1·81	,, -	— ,,
,, Nottingham	,, 48 ,,	,,	1·53	,, -	2·99	,, -	2·61	,, -	7·13 ,,
,, Holkham	,, 4 ,,	,,		,, -		,, -		,, -	,,

(*continued from page* 67.)
Halifax, and Silloth; on the 16th at Guernsey, Marlborough, Oxford, Royston, Cambridge, Cardington, Leicester, and Hull; on the 17th at Ventnor, Marlborough, Whitchurch, Barnet, Royston, Cardington, Cambridge, Wolverhampton, Nottingham, Halifax, and Hull; on the 18th at Halifax; on the 20th at Torquay, and Marlborough; on the 21st at Torquay, Bath, Barnet, Cambridge, Wolverhampton, and Hull; on the 22nd at Cardington; on the 23rd at Torquay, Barnet, Oxford, Lowestoft, and Hull.

Fog prevailed in April, on the 7th at Bath and Barnet; on the 11th at Rodmersham and Liverpool; on the 12th at Bath; on the 13th at Bath and Liverpool; on the 14th at Liverpool; on the 15th and 16th at Bath and Liverpool; on the 17th at Liverpool; on the 18th at Bradford; on the 19th at Bath and Cambridge; on the 27th at Bath; and on the 30th at Cambridge.

In May, on the 3rd at Cambridge; on the 4th at Wolverhampton; on the 14th at Liverpool; on the 25th at Guernsey; on the 26th at Guernsey and Ventnor; on the 27th at Guernsey, Torquay, and Bath; on the 28th at Torquay; and on the 30th at Torquay and Southbourne.

In June, on the 5th at Guernsey and Stonyhurst; on the 6th at Torquay and Ventnor; on the 7th at Guernsey, Torquay, Ventnor, Southbourne; on the 8th at Torquay, and Lowestoft; on the 15th at Lowestoft; on the 16th at Guernsey and Torquay; on the 17th at Guernsey; on the 20th at Bath; on the 23rd at Plymouth and Torquay; on the 24th at Torquay, Bath, and Wolverhampton; on the 25th at Bath; and on the 26th at Rodmersham.

NAMES OF STATIONS.	Mean Pressure of dry Air reduced to the level of the Sea.	Highest Reading of the Thermometer.	Lowest Reading of the Thermometer.	Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Wind: Mean Estimated Strength.	Wind: Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain: Number of Days on which it fell.	Rain: Amount collected.
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
Guernsey	[illegible]	77·0	33·0	44·0	[illegible]	[illegible]	[illegible]	11·[illegible]	50·4	44·7	·300	3·5	0·8	81	538	109·4	39·4	1·0	8	5	6	11	2·9	5·4	52	[illegible]
Truro	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18·0	49·4	43·7	·278	3·1	0·9	78	541	—	—	2·6	9	5	8	8	—	6·1	41	[illegible]
Plymouth	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13·8	50·9	45·0	·302	4·4	0·8	83	541	—	—	1·3	7	7	7	9	—	6·0	51	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18·4	50·7	43·6	·289	3·2	1·0	78	541	—	—	2·3	8	6	7	9	—	5·8	51	[illegible]
Torquay	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13·1	50·3	43·3	·285	3·2	0·9	77	537	112·8	37·7	1·3	7	7	7	10	5·3	6·1	47	[illegible]
Ventnor	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13·6	50·8	44·7	·301	3·3	0·9	80	540	—	—	1·0	6	8	5	11	—	5·6	40	[illegible]
Osborne	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18·7	50·8	43·1	·283	3·7	0·6	[illegible]	[illegible]	111·4	42·1	0·1	8	6	9	8	—	5·5	41	[illegible]
Southampton	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14·4	50·0	43·1	[illegible]	3·2	0·9	78	[illegible]	—	—	1·9	9	5	8	8	—	5·0	40	[illegible]
Salisbury	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	—	—	—	—	—	130·7	37·1	1·1	9	6	7	8	—	6·0	60	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13·8	[illegible]	47·2	·330	3·6	1·1	77	538	—	—	1·3	7	5	9	10	—	[illegible]	39	[illegible]
Bath	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14·0	[illegible]	42·2	[illegible]	3·1	0·8	79	536	112·0	30·0	1·6	9	4	7	10	—	[illegible]	47	[illegible]
[illegible]	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14·8	50·1	43·8	·289	3·3	0·9	80	—	104·8	35·6	1·6	9	4	9	8	4·3	6·0	40	[illegible]
Marlborough	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	43·3	·276	3·1	0·9	78	534	114·1	35·8	0·6	7	8	6	9	—	6·0	48	[illegible]
Whitchurch	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	43·1	[illegible]	3·2	1·1	[illegible]	[illegible]	—	—	1·4	7	8	6	10	—	5·1	46	[illegible]
Blackheath	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44·2	·296	3·4	1·0	[illegible]	[illegible]	114·5	—	0·9	5	9	7	9	—	4·8	32	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44·4	[illegible]	[illegible]	1·2	[illegible]	[illegible]	[illegible]	36·8	—	—	—	—	—	4·7	6·1	[illegible]	[illegible]
Camden Square	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1·8	71	[illegible]	[illegible]	39·5	—	6	9	7	9	—	5·5	41	[illegible]
Barnet	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	·279	3·2	1·0	[illegible]	[illegible]	[illegible]	[illegible]	1·0	7	9	4	11	—	5·5	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1·2	74	[illegible]	109	[illegible]	[illegible]	9	3	8	9	4·7	5·8	51	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3·1	[illegible]	[illegible]	[illegible]	—	—	—	9	3	8	8	—	5·7	42	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3·2	1·2	73	[illegible]	[illegible]	[illegible]	1·0	5	6	6	10	—	[illegible]	—	—
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3·4	0·9	79	[illegible]	[illegible]	[illegible]	1·2	7	6	5	12	—	6·0	42	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3·1	1·0	[illegible]	[illegible]	[illegible]	[illegible]	2·0	7	7	7	10	—	5·5	41	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	2·0	[illegible]	[illegible]	7	9	[illegible]	5·1	41	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	—	[illegible]	[illegible]	6	9	—	6·7	45	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7	9	—	6·1	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10	—	6·1	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	541	—	—	[illegible]	[illegible]	[illegible]	[illegible]	14	—	6·4	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	[illegible]	[illegible]	[illegible]	11	—	5·5	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10	—	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	[illegible]	[illegible]	14	—	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	[illegible]	[illegible]	[illegible]	10	—	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	6·4	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	44	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2·6	[illegible]	[illegible]	[illegible]

The highest temperatures of the air were at Blackheath, [illegible], at Cambridge, [illegible], at Darlington, [illegible].
The lowest temperatures of the air were at Salisbury, [illegible], [illegible], and [illegible].
The greatest ranges of temperature were at Salisbury, [illegible], at [illegible], at Whitehaven, [illegible].
The least ranges of temperature were at Guernsey and [illegible], at Liverpool, [illegible].
The greatest [illegible] were at Salisbury, [illegible], at Nottingham, [illegible], at [illegible].
The least [illegible] were at [illegible], at Blackheath, [illegible], at [illegible].
The greatest falls of rain were at [illegible], at [illegible], at [illegible].
The least falls of rain were at [illegible], at [illegible], at [illegible].

QUARTERLY METEOROLOGICAL TABLE for different PARALLELS of LATITUDE.

PARALLELS OF LATITUDE, &c.	[illegible]	Wind: Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Number of Days on which it fell.	Rain: Amount collected.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

METEOROLOGY OF ENGLAND,

DURING THE QUARTER ENDING SEPTEMBER 30, 1885.

Remarks on the Weather during the Quarter ending Sept. 30th, 1885.

By James Glaisher, Esq., F.R.S., *&c.*

The weather in July was warm, the temperature being generally above the average. The barometer readings were high throughout the month. There were but three days in the month, viz., the 18th, 19th, and 20th, when the atmospheric pressure was a little less than the average. The month was remarkably dry, the fall of rain was less than half an inch at very many places, and at some the fall was less than a quarter of an inch, and at Whitchurch was less than the tenth of an inch. There was only one thunderstorm, viz., on the 13th, and that was only experienced at, about and a little north of London. The almost total absence of either lightning or thunder was remarkable, and no hail fell. The want of rain at the end of the month was severely felt by all root crops.

The month of August was cold, there were only two days in the month, viz., the 16th and 17th, when the mean temperature reached its average. The atmospheric pressure was variable, for a few days together above its average, and then a few days below. The fall of rain was generally less than the average, but sufficient to save the root crops. The month on the whole was fine and dry, and was favourable for harvest work.

The weather in September was unsettled, the temperature was variable, being for a few days together a little above the average, then for a few days a little below till the last week in the month when the cold was very severe. The atmospheric pressure was below its average till the 15th, and again after the 25th. The rainfall was considerably above its average, and it fell at most places on two out of three days during the month. The first snow fell at Carlisle on the 26th.

About London the mean daily temperature of the air was for the first fourteen days in July above its average by 1°·4 daily. From July 15th to the 18th there was a deficiency of 1°·0; from July 19th to the 27th there was an excess of temperature of 2°·9 daily; from July 28th to August 15th the temperature was low, being 2°·6 below the average; August 16th and 17th were above their averages by 1°·6 and 1°·9 respectively; for the next sixteen days, viz., from August 18th to September 2nd, the temperature was cold, being 4°·2 daily below the average values, for the next four days the temperature was much higher, being 1°·3 above the daily average, then for six days much lower, being below by 2°·7 daily; from September 13th to 23rd the temperature was variable, being for four and three days together alternately above and below, and for the last week in the quarter the deficiency of mean temperature equalled 7°·6 daily.

The mean temperature of the air for July was 63°·8, being 2°·1 and 1°·7 above the averages of 114 years and 44 years respectively; it was 0°·4, 3°·9, and 3°·4 higher than in 1884, 1883, and 1882 respectively.

The mean temperature of the air for August was 58°·5, being 2°·4 and 3°·0 below the averages of 114 years and 44 years respectively; it was 6°·8, 3°·4, and 1°·1 lower than in 1884, 1883, and 1882 respectively.

The mean temperature of the air for September was 55°·1, being 1°·4 and 2°·0 below the averages of 114 years and 44 years respectively; it was 4°·2 and 1°·7, lower than in 1884 and 1883, respectively; and 0°·8 higher than in 1882.

The mean temperature of the quarter was 59°·1, being 0°·6 and 1°·1 below the averages of 114 years and of 44 years respectively.

The mean high day temperature of the air in July was 77°·0, being 2°·9 above the average of 44 years; in August it was 69°·8, being 3°·2 below the average of 44 years; and in September it was 64°·7, being 2°·7 below the average of 44 years.

The mean low night temperature of the air in July was 52°·5, being 0°·6 below the average of 44 years; in August it was 49°·8, being 3°·4 below the average of 44 years; and in September it was 47°·2, being 2°·0 below the average of 44 years.

The mean daily range of temperature in July was 24°·5, being 3°·5 above the average; in August it was 20°·0, being 0°·2 above the average; and in September it was 17°·5, being 0·8 below the average.

The mean temperature of the air for July was 4°·3 higher than in June; in August it was 5°·3 lower than in July; and in September it was 3°·4 lower than in August.

(From the preceding 44 years' observations the increase of temperature from June to July is 3°·2, the decrease from July to August is 0°·6, and the decrease from August to September is 4°·4.)

From June to July there was an increase of temperature at stations south of 51° of 3°·0, between 51° and 52° of 3°·7, between 52° and 53° of 5°·9, between 53° and 54° of 4°·4, and north of 54° of 4°·6.

From July to August there was a decrease of temperature at stations south of 51° of 1°·7, between 51° and 52° of 4°·2, between 52° and 53° of 4°·4, between 53° and 54° of 4°·1, and north of 54° of 3°·8.

From August to September there was an decrease of temperature at stations south of 51° of 2°·6, between 51° and 52° of 3°·0, between 52° and 53° of 2°·4, between 53° and 54° of 2°·2, and north of 54° of 2°·4.

1885. Months.	Temperature of Air. Mean.	Air. Diff. from average of 114 years.	Air. Diff. from average of 44 years.	Evaporation. Mean.	Evaporation. Diff. from average of 44 years.	Dew Point. Mean.	Dew Point. Diff. from average of 44 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 44 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 44 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 44 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	grs.
July -	63·8	+2·1	+1·7	58·0	+0·3	53·2	−0·8	24·5	+3·5	·406	−0·012	4·5	−0·2
Aug. -	58·5	−2·4	−3·0	54·4	−3·1	50·8	−3·2	20·0	+0·2	·371	−0·049	4·2	−0·5
Sept. -	55·1	−1·4	−2·0	52·5	−1·5	50·0	−1·2	17·5	−0 8	·391	−0·019	4·0	−0·3
Means -	59·1	−0·6	−1·1	55·0	−1·4	51·3	−1·7	20·7	+1·0	·379	−0·027	4·2	−0·3

1885. Months.	Degree of Humidity. Mean.	Humidity. Diff. from average of 44 years.	Reading of Barometer. Mean.	Barometer. Diff. from average of 44 years.	Weight of a Cubic Foot of Air. Mean.	Weight. Diff. from average of 44 years.	Rain. Amount.	Rain. Diff. from average of 70 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
July -	69	− 7	29·996	+0·202	530	+ 2	0·50	−2·04	222	0	9	22	32·6	57·8
Aug. -	76	0	29·796	+0·013	533	+ 4	1·32	−1·06	259	0	13	18	30·4	52·8
Sept. -	83	+ 2	29·713	−0·086	534	+ 1	3·73	+1·30	275	3	9	18	22·3	55·8
Means -	76	− 2	29·835	+0·043	532	+ 2	Sum 5·55	Sum −1·80	Mean 252	Sum 3	Sum 31	Sum 58	Lowest 22·3	Highest 57·8

NOTE.—In reading this table it will be borne in mind that the plus sign (+) signifies *above* the average, and the minus sign (−) signifies *below* the average.

Average duration of the different directions of the wind referred to eight points of the compass, and duration of each direction in each month in the quarter, were as follows:—

Direction of Wind.	July. 1885.	July. Average.	July. Departure from Average.	August. 1885.	August. Average.	August. Departure from Average.	September. 1885.	September. Average.	September. Departure from Average.
	d.	d.	d.	d.	d.	d.	d.	d.	d.
N.W.	3¼	2¾	+ ½	8¼	2½	+5¾	7½	2	+5½
N.	¼	3¼	− 3	2	3¼	−1¼	1	4¾	−3¾
N.E.	2¼	3¼	− 1	3½	3½	0	1	5¼	−4¼
E.	10	1¾	+ 8¼	6¼	1¾	+4½	3¼	2¼	+1
S.E.	0	1	− 1	1½	1½	0	½	2	−1½
S.	¼	3	− 2¾	1¼	3½	−2¼	1¼	3	−1¾
S.W.	11¾	11	+ ¾	15½	10¼	−5¼	13¼	8	+5¼
W.	2½	4½	− 2	3	4½	−1½	1	3	−2

The plus sign (+) denotes excesses over averages; the largest numbers affected with this sign in the month of July are opposite to E. and S.W.; in August to N.W. and E.; and in September to N.W. and S.W.

The minus sign (−) denotes deficiencies below averages. In July the largest numbers are opposite to N. and S.; in August to S.W. and S.; and in September to N.E. and N.

The mean reading of the barometer for the month of July at the height of 159 ft. above the level of the sea was 29·996 ins., being 0·202 in. above the average of 44 years, and 0·216 in., 0·308 in., and 0·296 in. higher than in 1884, 1883, and 1882 respectively.

The mean reading of the barometer for the month of August was 29·796 ins., being 0·013 in· above the average of 44 years, and 0·039 in., 0·045 in. lower than in 1884 and 1883 respectively, and 0·056 in. higher than in 1882.

The mean reading of the barometer for the month of September was 29·713 ins., being 0·086 in. below the average of 44 years, and 0·122 in. lower than in 1884, 0·065 in. and 0·026 in. higher than in 1883 and 1882 respectively.

From June to July there was an increase at stations south of 51° of 0·145 in., between 51° and 52° of 0·145 in., between 52° and 53°, of 0·135 in., between 53° and 54° of 0·126 in., and north of 54° of 0·113 in.

From July to August there was a decrease at stations south of 51° of 0·217 in., between 51° and 52° of 0·209 in., between 52° and 53° of 0·192 in., between 53° and 54° of 0·189 in., and north of 54° of 0·162 in.

From August to September there was a decrease at stations south of 51° of 0·054 in., between 51° and 52° of 0·078 in., between 52° and 53° of 0·133 in., between 53° and 54° of 0·139 in., and north of 54° of 0·202 in.

About London the barometer pressure was for the first seventeen days in July above its average by 0·15 in. daily, for three days the pressure was nearly the same as the average; from July 21st to August 5th, the barometer readings were high, being 0·27 in. in excess of their averages; from August 6th to the 12th there was a deficiency of 0·11 in.; the next week was in excess by 0·22 in. daily; then for four days a deficiency of 0·11 in.; August 24th and 25th being nearly the same as their averages; from August 26th to September 15th, there was a deficiency of pressure to the amount of 0·24 in. the next four days were the same as the average; from September 20th to the 24th, the excess of pressure equalled 0·20 in.; from September 25th to the end of the quarter there was a slight deficiency of 0·07 in.

Thunderstorms occurred in July on the 13th at Camden Square and Cambridge.

In August on the 5th at Rodmersham, Barnet, Cambridge, Wolverhampton, Leicester; on the 6th at Truro, Totnes, Torquay, Ventnor, Whitchurch, Barnet, Oxford, Wolverhampton, Leicester, Liverpool, Hull, and Stonyhurst; on the 7th at Salisbury, Marlborough, Whitchurch, Camden Square, Barnet, Oxford, Lowestoft, Wolverhampton, Halifax; on the 12th at Bolton, Stonyhurst; on the 20th at Rodmersham, Camden Square, Halifax; on the 23rd at Torquay.

In September on the 2nd at Halifax and Hull; on the 3rd at Oxford, Leicester, Nottingham, Burslem, Bolton, Hull, Bradford; on the 4th at Burslem, Liverpool, Bolton, Hull, Stonyhurst; on the 5th at Bolton and Hull; on the 6th at Plymouth, Torquay; on the 7th at Plymouth, Oxford, Wolverhampton, Nottingham; on the 9th at Lowestoft, Burslem, Liverpool; on the 16th and 17th at Rodmersham; on the 25th at Torquay; and on the 30th at Stonyhurst.

Thunder was heard but lightning was not seen in July, on the 5th at Southbourne; and on the 20th at Halifax and Stonyhurst.

In August on the 4th of Oxford; on the 5th at Royston; on the 6th at Guernsey, Osborne, Camden Square, Royston, Cambridge, Bolton, Halifax, Bradford; on the 7th at Whitchurch, Oxford, Royston, Cambridge, Somerleyton, Hull; on the 12th at Llandudno; on the 23rd at Plymouth and Totnes; on the 25th at Halifax.

In September on the 2nd at Burslem; on the 3rd at Marlborough, Rugby, Wolverhampton, Halifax; on the 4th at Cambridge; on the 5th at Cambridge, Rugby, Somerleyton; on the 7th at Blackheath, Barnet; on the 9th at Lowestoft, Somerleyton; on the 10th at Rugby; on the 14th at Liverpool; and on the 25th at Blackheath.

Lightning was seen but thunder was not heard in July, on the 13th at Barnet; on the 16th at Cardington.

In August on the 4th at Oxford; on the 5th at Torquay; on the 6th at Torquay, Southbourne, Salisbury, Rodmersham, Royston, Cambridge; on the 7th at Whitchurch; on the 10th at Rodmersham, Oxford, Cambridge.

In September on the 3rd at Lowestoft, Liverpool, Stonyhurst; on the 5th at Lowestoft, Liverpool; on the 7th at Rodmersham; on the 9th at Rodmersham, Barnet, Royston, Cambridge, Lowestoft, Liverpool; on the 11th at Liverpool; on the 24th at Lowestoft, Halifax, Hull; on the 25th and 26th at Torquay; on the 27th at Rodmersham, Lowestoft: and on the 30th at Bolton.

Solar halos were seen in July on the 2nd at Rodmersham and Halifax; on the 5th and 11th at Rodmersham; on the 14th at Torquay; on the 15th at Rodmersham; on the 18th at Halifax; on the 23rd at Torquay.

In August on the 3rd at Torquay; on the 8th at Torquay, Liverpool; on the 13th at Torquay; on the 16th at Torquay and Halifax; on the 17th at Rodmersham; on the 23rd and 25th at Torquay.

In September on the 1st at Torquay and Rodmersham; on the 4th at Rodmersham; on the 11th at Rodmersham and Halifax; on the 12th and 13th at Torquay; on the 16th at Torquay, Rodmersham, and Oxford; on the 21st at Torquay; on the 23rd and 24th at Rodmersham; on the 25th at Torquay; and on the 30th at Rodmersham.

Lunar halos were seen in July on the 25th at Bolton.

In August on the 25th at Rodmersham.

In September on the 1st and 19th at Oxford; on the 21st at Bolton, Halifax, Bradford; on the 22nd at Stonyhurst; on the 24th at Oxford; and on the 29th at Halifax.

Auroræ Boreales were seen in July on the 1st at Leicester; on the 21st at Leicester, Carlisle; on the 22nd at Carlisle; and on the 27th at Leicester.

In September on the 11th at Stonyhurst.

Snow fell in September on the 26th at Carlisle.

Hail fell in August, on the 6th at Whitchurch and Leicester; on the 7th at Oxford; on the 12th at Halifax; on the 20th at Rodmersham, Halifax. In September on the 3rd at Leicester, on the 5th at Burslem; on the 9th at Burslem and Halifax; on the 10th at Bolton; on the 11th at Liverooool; on the 24th at Liverpool, Bolton; on the 25th at Truro, Torquay, Halifax, Hull; on the 26th at Truro and Carlisle; on the 27th at Royston; and on the 30th at Halifax, Stonyhurst and Carlisle.

MONTHLY METEOROLOGICAL TABLE FOR THE QUARTER ENDING SEPTEMBER 30TH, 1885.

The Observations have been reduced to Mean values by Glaisher's Barometrical and Diurnal Range Tables, and the Hygrometrical results have been deduced from the sixth edition of his Hygrometrical Tables.

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1885. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.
	feet.		in.	in.	°	°	°	°	°	°	°	°
GUERNSEY, ADOLPHUS COLLENETTE, Esq., F. R. Met. Soc.	270	July	29·912	0·389	79·6	45·3	34·3	66·7	52·8	13·9	58·5	53·5
		Aug.	29·683	0·636	73·6	45·5	28·1	66·2	53·6	12·6	56·6	54·5
		Sept.	29·869	0·757	59·5	44·8	14·7	62·5	52·9	9·6	57·2	51·6
TRURO (Cornwall), N. WHITLEY, Esq., F. R. Met. Soc.	48	July	30·018	0·436	89·0	38·0	51·0	71·6	50·8	20·8	58·6	54·1
		Aug.	29·796	0·666	78·0	40·0	38·0	69·8	48·4	21·4	57·1	49·8
		Sept.	29·757	0·881	70·0	30·0	40·0	64·0	48·9	15·1	54·9	51·7
PLYMOUTH (Devon), J. MERRIFIELD, Esq., LL.D., F.R.A.S., F. R. Met. Soc.	69	July	30·093	0·477	81·2	45·0	36·2	69·7	54·1	15·6	61·3	55·4
		Aug.	29·880	0·668	75·3	44·0	31·3	67·5	51·5	16·0	58·9	51·7
		Sept.	29·823	0·791	66·0	34·5	31·5	62·2	49·2	13·0	55·1	51·4
TOTNES (Devon), T. H. EDMONDS, Esq.	107	July	30·098	0·508	88·2	37·7	50·5	71·4	49·1	22·3	59·9	52·2
		Aug.	29·886	0·692	80·3	38·8	41·5	69·2	46·1	23·1	57·7	49·5
		Sept.	29·816	0·792	70·2	28·3	41·9	64·3	46·7	17·6	55·6	49·1
TORQUAY, Babbacombe (Devon), EDWIN E. GLYDE, Esq., F. R. Met. Soc.	305	July	29·876	0·552	85·6	44·9	40·7	69·4	53·6	15·8	60·7	50·4
		Aug.	29·657	0·716	80·6	44·7	35·9	66·5	51·8	14·7	58·4	50·0
		Sept.	29·586	1·273	67·8	36·0	31·8	62·5	49·9	12·6	55·5	49·5
VENTNOR, (Isle of Wight) (Royal National Hospital for Consumption), HARTLEY SAGAR, Esq.	80	July	30·070	0·491	83·0	49·6	33·4	68·7	55·7	13·0	60·5	53·4
		Aug.	29·866	0·630	75·8	45·5	30·3	67·4	54·7	12·7	59·2	50·4
		Sept.	29·795	0·791	69·6	36·6	33·0	63·4	52·6	10·8	56·3	50·1
OSBORNE (Isle of Wight), J. R. MANN, Esq.	172	July	29·995	0·498	94·5	45·6	48·9	74·6	52·8	21·8	61·6	55·9
		Aug.	29·796	0·636	81·2	45·0	36·2	71·1	51·7	19·4	59·5	52·0
		Sept.	29·726	0·846	72·7	36·0	36·7	64·9	49·4	15·5	55·6	53·1
SOUTHBOURNE, (near) Bournemouth (Hants), T. A. COMPTON, Esq., M.D., B.A., F. R. Met. Soc.	95	July	30·069	0·510	82·9	44·0	38·9	69·5	51·7	17·8	59·7	52·1
		Aug.	29·839	0·632	75·4	41·2	34·2	67·5	49·8	17·7	58·0	48·9
		Sept.	29·791	0·790	67·4	32·5	34·9	63·1	49·6	13·5	55·8	49·8
BRIGHTON, F. E. SAWYER, Esq., F.S.A., F. R. Met. Soc.	206	April	29·571	1·085	65·6	30·0	35·6	54·6	40·0	14·6	46·8	38·9
		May	29·623	1·048	68·2	35·0	33·2	59·0	43·3	15·7	50·1	41·7
		June	29·817	0·863	75·5	43·0	32·5	66·6	51·5	15·1	57·8	49·9
		July	29·966	0·485	84·4	48·5	35·9	70·7	54·1	16·6	61·3	51·1
		Aug.	29·766	0·633	71·5	43·3	28·2	67·0	52·0	15·0	58·4	50·9
		Sept.	29·694	0·733	70·0	34·0	36·0	63·1	49·8	13·3	56·7	50·9
SALISBURY (Wilton House), Wilts, THOMAS CHALLIS, Esq.	186	July	29·963	0·540	84·0	29·0	55·0	79·0	47·8	31·2	61·7	56·3
		Aug.	29·755	0·634	83·0	36·0	47·0	71·6	44·2	27·4	57·5	50·2
		Sept.	29·662	0·814	72·0	27·0	45·0	65·0	43·2	21·8	54·4	48·5

Names of Stations and Observers.	Months.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity, Sat. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
		in.	grs.	gr.		grs.	°	°									in.
GUERNSEY	July	·411	4·3	0·9	88	534	119·1	47·3	0·8	8	9	2	12	2·0	4·4	6	0·34
	Aug.	·425	4·7	0·8	85	529	117·2	45·9	1·1	6	8	9	8	2·1	4·9	10	1·51
	Sept.	·383	4·3	1·0	82	541	107·3	47·2	1·1	8	2	7	13	3·4	6·1	26	4·73
TRURO	July	·419	4·7	0·8	84	535	—	—	1·9	6	6	7	12	—	4·9	7	0·40
	Aug.	·369	4·0	1·2	76	533	—	—	2·2	9	9	6	7	—	5·2	11	3·16
	Sept.	·385	4·4	0·6	89	535	—	—	2·4	6	0	9	15	—	5·7	25	6·58
PLYMOUTH	July	·439	4·7	0·9	80	516	—	—	1·0	7	9	3	12	—	5·1	9	0·42
	Aug.	·384	4·6	1·4	77	533	—	—	1·2	7	12	7	5	—	5·4	10	2·11
	Sept.	·380	4·3	0·6	87	536	—	—	1·4	7	2	8	13	—	6·5	22	4·39
TOTNES	July	·392	4·3	1·5	76	536	—	—	1·2	9	7	4	11	—	5·4	5	0·51
	Aug.	·354	3·9	1·3	78	534	—	—	2·2	7	14	5	5	—	5·1	12	2·06
	Sept.	·350	3·9	1·0	79	536	—	—	2·4	8	1	7	14	—	5·9	23	4·74
TORQUAY	July	·366	4·1	1·8	63	531	126·6	46·6	1·1	8	9	4	10	3·7	5·3	4	0·23
	Aug.	·362	4·1	1·4	74	530	123·0	45·0	1·5	9	10	5	7	4·7	5·2	18	2·76
	Sept.	·355	3·9	1·0	80	531	115·4	43·0	1·6	5	3	7	15	5·5	6·4	21	3·28
VENTNOR	July	·409	4·6	1·4	78	535	—	—	0·8	6	9	5	11	—	5·3	4	0·69
	Aug.	·366	4·1	1·6	78	533	—	—	1·0	6	10	9	6	—	5·5	8	0·31
	Sept.	·360	4·0	1·1	77	534	—	—	1·1	5	4	7	14	—	6·2	19	3·89
OSBORNE	July	·447	5·0	1·1	82	532	121·4	52·0	0·1	5	5	11	10	—	3·8	6	0·71
	Aug.	·386	4·3	1·4	77	531	120·2	50·1	0·4	8	7	9	7	—	5·0	12	0·45
	Sept.	·405	4·6	0·4	91	533	106·4	48·1	0·2	6	1	12	11	—	6·9	19	4·66
SOUTHBOURNE	July	·390	4·4	1·4	76	535	—	—	1·2	9	7	8	7	—	4·2	6	0·29
	Aug.	·347	3·9	1·5	72	533	—	—	1·6	10	11	4	6	—	4·4	8	0·38
	Sept.	·360	4·0	1·0	80	535	—	—	1·5	8	2	6	14	—	4·9	19	3·56
BRIGHTON	April	·237	2·7	1·0	74	541	—	33·7	1·3	7	10	7	6	—	4·9	10	0·83
	May	·264	3·0	1·1	78	538	101·9	38·0	0·9	4	3	9	15	—	7·8	17	3·00
	June	·340	3·7	1·6	71	538	107·6	46·4	1·4	7	8	8	7	—	4·7	7	1·40
	July	·375	4·2	1·9	70	532	107·7	47·5	1·0	5	7	7	11	—	3·9	6	0·56
	Aug.	·350	4·2	1·5	74	531	109·0	45·6	1·5	7	5	8	11	—	5·4	8	0·53
	Sept.	·373	4·2	0·9	81	532	95·9	43·7	1·8	8	3	9	10	—	5·7	19	4·23
SALISBURY	July	·455	5·0	1·2	83	531	126·0	46·1	1·0	9	6	10	6	—	4·8	6	0·15
	Aug.	·365	3·1	1·2	77	532	118·3	42·2	1·1	11	8	10	3	—	5·8	12	1·00
	Sept.	·342	3·9	0·9	80	534	99·6	41·6	1·1	9	2	9	10	—	6·6	27	4·30

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1885. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean. Of all Highest.	Temperature of Air in Month. Mean. Of all Lowest.	Temperature of Air in Month. Mean. Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a Cubic foot of Air. Mean.	Vapour. In a Cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Sat. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	Wind. Relative Proportion of E.	Wind. Relative Proportion of S.	Wind. Relative Proportion of W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr		grs.	°	°									in.
EASTBOURNE. Miss W. L. Hall,	12	Mar.	30·017	1·340	55·0	28·4	26·6	47·9	34·8	13·1	40·9	36·8	·218	2·5	0·5	86	556	92·4	31·2	0·8	12	10	5	4	0·8	—	10	2·87
		April	29·740	1·062	69·9	30·1	39·8	56·5	43·5	13·0	48·7	44·6	·295	3·5	0·5	86	542	144·7	34·7	0·3	8	8	9	5	1·5	—	10	1·10
		May	29·777	0·814	69·4	35·2	34·2	55·7	44·3	11·4	49·8	42·4	·271	3·1	1·0	75	541	114·5	48·4	0·4	4	4	10	18	0·4	—	9	2·59
		June	29·968	0·790	78·0	40·5	37·5	69·1	52·7	16·4	58·9	55·1	·435	4·8	0·8	87	534	118·0	48·8	0·4	4	13	7	6	0·4	—	7	0·78
		July	30·160	0·402	87·1	44·3	42·8	61·3	52·5	8·8	56·3	51·2	·377	4·1	1·3	76	539	119·3	—	0·3	2	9	8	12	1·0	—	8	0·80
		Aug.																										
		Sept.																										
BARNSTAPLE (Devon), William Knill, Esq.	43	July	30·169	0·530	90·0	45·5	44·5	73·3	59·9	13·4	64·6	54·1	·420	4·8	1·7	75	531	—	—	1·1	5	6	8	12	—	2·7	6	0·94
		Aug.	29·908	0·620	79·0	46·5	32·5	70·0	55·6	14·4	60·7	51·9	·387	4·3	1·6	72	531	—	—	1·3	6	11	8	6	—	1·8	10	1·05
		Sept.	29·860	0·860	73·0	38·0	35·0	64·8	52·1	12·7	57·2	51·8	·386	4·8	1·0	82	535	—	—	1·5	7	2	10	11	—	3·3	20	6·88
BATH (Somerset), St. Gregory's College, Downside, Rev. T. J. Almond, O.S.B.	596	July	29·536	0·548	84·9	44·3	40·6	69·5	51·9	17·6	59·3	53·3	·398	4·3	1·3	78	536	127·9	39·0	1·3	8	2	3	13	—	5·0	8	0·60
		Aug.	29·328	0·683	73·2	41·5	31·7	64·1	48·4	15·7	55·6	48·6	·344	3·8	1·1	78	527	119·5	—	1·7	9	7	8	7	—	5·5	14	2·48
		Sept.																										
BODMERSHAM, near Sittingbourne (Kent), R. M. Mercer, Esq., F.R. Met. Soc.	140	July	—	—	81·5	39·5	42·0	69·8	50·5	19·3	59·5	52·9	·401	4·7	1·2	80	—	135·9	48·3	1·4	9	8	9	5	2·5	5·5	4	0·21
		Aug.	—	—	76·6	38·2	38·4	65·3	49·2	16·1	56·6	49·9	·360	4·0	1·1	78	—	130·9	42·4	1·7	13	8	4	6	1·8	6·3	8	1·05
		Sept.	—	—	74·5	34·0	40·5	62·5	47·4	15·1	54·9	49·4	·352	3·9	1·0	82	—	112·8	40·9	1·6	6	3	11	10	2·5	5·6	16	4·55
MARLBOROUGH (Wilts), Rev. Thomas A. Preston, M.A., F. R. Met. Soc.	456	July	29·677	0·560	87·1	41·4	45·7	72·9	50·7	22·2	60·5	52·7	·399	4·3	1·4	75	528	133·2	46·2	0·4	7	9	4	11	—	4·8	7	0·31
		Aug.	29·474	0·663	77·4	35·2	42·2	66·7	47·6	19·1	56·3	48·2	·339	3·8	1·1	73	529	121·8	41·8	0·6	7	12	6	6	—	6·1	12	0·81
		Sept.	29·365	0·890	71·2	30·0	41·2	62·1	46·0	16·1	53·4	47·4	·327	3·6	0·9	80	530	112·8	40·2	0·7	6	2	9	14	—	5·8	22	4·71
BLACKHEATH (Kent), James Glaisher, Esq., F.R.S.	150	July	29·998	0·588	87·1	47·5	39·6	76·3	54·2	22·1	63·7	53·2	·406	4·5	1·6	69	530	124·7	—	0·6	4	11	6	10	—	4·5	4	0·46
		Aug.	29·801	0·690	77·5	43·0	34·5	68·5	50·7	17·8	58·1	49·7	·359	4·0	1·4	74	532	112·2	—	1·4	8	8	5	10	—	5·2	10	1·38
		Sept.	29·720	0·908	74·5	35·5	39·0	66·1	48·2	14·9	54·8	48·9	·346	3·8	1·3	80	535	100·1	—	1·	5	4	9	12	—	6·0	17	3·67
ROYAL OBSERVATORY, Greenwich, W. H. M. Christie, M.A., F.R.S., Astronomer Royal.	159	July	29·996	0·569	90·2	44·7	45·5	77·0	52·5	24·5	63·8	53·2	·406	4·5	2·0	69	530	148·0	44·7	—	—	—	—	—	2·4	5·4	5	0·50
		Aug.	29·796	0·673	80·2	40·2	40·0	69·8	49·8	20·0	58·5	50·8	·371	4·2	1·3	76	532	129·2	41·4	—	—	—	—	—	3·5	6·9	10	1·32
		Sept.	29·718	0·861	76·4	30·6	45·8	64·7	47·2	17·5	55·1	50·0	·361	4·0	0·9	83	534	107·7	40·1	—	—	—	—	—	3·3	6·8	21	3·73
WHITCHURCH RECTORY (Oxon), (near Reading), Rev. J. Slatter, M.A., F.R. Met. Soc.	150	July	30·046	0·565	88·0	43·5	44·5	75·6	49·0	26·6	61·8	51·5	·379	4·2	1·9	69	533	—	—	0·8	5	10	8	8	—	3·9	4	0·07
		Aug.	29·852	0·680	79·5	38·4	41·1	69·2	46·4	22·8	57·1	47·9	·333	3·8	1·4	73	534	—	—	1·4	7	13	4	7	—	6·2	9	0·87
		Sept.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CAMDEN SQUARE (London), G. J. Symons, Esq., F.R.S., F. R. Met. Soc.	128	July	30·044	0·573	90·4	47·6	42·8	76·6	54·7	21·9	61·0	49·8	·358	4·0	2·0	67	534	117·0	49·6	—	8	11	4	8	—	5·4	6	0·52
		Aug.	29·839	0·656	74·8	43·3	31·5	69·2	51·0	18·2	58·6	49·5	·355	3·8	1·6	72	533	105·4	45·9	—	7	11	6	7	—	6·1	12	0·85
		Sept.	29·758	0·816	76·5	33·7	42·8	64·8	48·4	16·4	55·5	48·4	·343	3·8	1·1	78	535	97·7	43·0	—	11	3	7	9	—	5·5	19	4·30
BARNET (Gas Works), T. H. Martin, Esq., C.E.	212	July	29·976	0·578	88·0	40·1	47·9	75·9	49·6	26·3	61·6	51·2	·376	4·2	1·9	69	532	135·1	46·7	0·6	7	11	3	10	—	4·3	2	0·17
		Aug.	29·777	0·681	78·1	34·0	44·1	68·3	46·1	22·2	56·2	48·4	·338	3·8	1·2	75	534	121·2	42·8	0·9	10	11	3	7	—	6·5	10	1·60
		Sept.	29·684	0·891	77·1	27·7	49·4	64·4	43·9	20·5	53·6	49·8	·350	4·0	0·7	85	535	111·2	40·2	0·6	9	2	4	15	—	6·1	17	3·51
OXFORD (The Observatory), E. J. Stone, Esq., M.A., F.R.S.	210	July	29·943	0·590	85·8	44·2	41·6	72·9	53·1	19·8	63·1	53·1	·389	4·3	2·1	67	530	128·7	47·3	2·1	9	5	6	11	5·0	4·6	2	0·12
		Aug.	29·758	0·725	76·1	41·3	34·8	66·6	49·9	16·7	57·8	50·0	·361	4·0	1·3	75	532	118·1	43·7	2·5	11	7	6	7	4·7	6·4	8	1·60
		Sept.	29·649	0·844	73·7	32·2	41·5	63·2	47·7	15·5	55·1	49·2	·352	3·9	1·0	82	533	110·5	40·7	2·9	5	3	12	10	2·7	6·2	20	4·35
ROYSTON (Hertfordshire), Hale Wortham, Esq., F.R.A.S., F. R. Met. Soc.	269	July	29·917	0·622	87·6	43·4	44·2	75·0	52·2	22·8	60·9	54·6	·426	4·8	1·2	80	531	—	—	—	8	8	7	8	—	5·0	4	0·21
		Aug.	29·726	0·695	77·9	40·9	37·0	67·8	49·2	18·6	56·8	49·4	·352	3·8	1·2	76	533	—	—	—	11	6	6	8	—	6·4	10	2·06
		Sept.	29·629	0·856	75·9	32·5	43·4	63·2	46·7	16·5	53·3	47·6	·330	3·7	0·8	80	534	—	—	—	8	3	7	12	—	5·2	18	3·15
BEDFORD, Cardington, Mr. J. McLaren, Assistant to S. Whitbread, Esq., M.P.	105	July	30·069	0·620	91·2	43·2	48·0	76·8	50·7	26·1	63·8	51·7	·385	4·2	2·2	66	533	118·7	48·1	4·3	8	5	5	13	—	4·3	3	0·21
		Aug.	—	—	79·0	37·4	41·6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2·50
		Sept.	—	0·893	78·6	30·5	48·1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3·70

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1885. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs	°	°									in.
CAMBRIDGE (Trinity College), J. W. L. Glaisher, Esq., M.A., F.R.S.	40	July	30.184	0.610	90.0	42.5	47.5	76.3	50.8	25.5	61.8	53.7	.412	4.5	1.6	75	534	142.5	46.5	4.7	6	18	3	9	—	4.8	5	0.75
		Aug.	29.917	0.716	78.9	39.1	39.8	69.7	48.3	21.4	57.4	49.0	.347	3.9	1.4	73	535	130.7	44.0	1.4	6	10	2	13	—	6.6	10	1.01
		Sept.	29.808	0.940	78.0	30.2	47.8	65.6	45.8	19.8	54.7	50.4	.366	4.2	0.7	86	536	118.7	40.9	1.3	3	2	9	16	—	6.2	23	2.97
RUGBY (Warwickshire), Stockton, The Rectory, Rev. W. Tuckwell.	280	July	29.834	0.638	90.8	40.2	50.6	75.0	50.0	25.0	61.6	51.4	.379	4.2	1.9	70	529	—	—	0.5	6	7	8	10	—	4.7	8	0.20
		Aug.	29.657	0.678	78.0	36.0	42.0	67.4	47.1	20.8	55.4	51.1	.376	4.3	0.7	90	533	—	—	0.6	12	8	5	6	—	7.4	12	2.64
		Sept.	29.502	1.040	73.0	26.8	46.2	63.5	43.3	20.2	53.0	47.6	.330	3.7	0.8	82	532	—	—	0.6	6	4	13	7	—	6.5	17	2.70
LOWESTOFT (Suffolk), S. H. Miller, Esq., F.R.A.S., F. R. Met. Soc.	89	July	30.058	0.662	76.0	42.0	34.0	66.8	53.1	13.7	59.3	51.0	.374	4.2	1.5	73	536	116.4	49.3	1.6	5	12	10	4	—	6.0	11	0.33
		Aug.	29.851	0.694	76.0	39.5	36.5	65.0	51.0	14.0	57.2	48.3	.339	3.8	1.5	72	534	114.5	47.2	2.2	8	11	4	8	—	6.9	8	0.67
		Sept.	29.749	1.014	76.7	32.7	44.0	62.7	48.5	14.2	55.0	49.5	.354	4.0	0.9	82	535	106.8	44.7	1.8	5	2	8	15	—	5.9	23	5.36
SOMERLEYTON (Suffolk), The Rectory, Rev. C. J. Steward, F. R. Met. Soc.	50	July	30.102	0.614	79.8	41.2	38.6	67.8	51.6	16.2	58.5	52.6	.397	4.5	1.1	81	527	—	—	0.9	8	11	7	5	6.3	4.7	11	0.74
		Aug.	29.906	0.692	75.5	40.3	35.2	64.7	50.5	14.4	56.3	48.0	.336	3.8	1.3	72	536	—	—	1.1	11	7	5	8	6.8	6.2	9	1.51
		Sept.	29.807	0.894	72.0	33.0	39.0	62.2	47.9	14.3	54.1	49.9	.359	4.1	0.6	85	537	—	—	1.1	6	3	8	13	5.9	6.0	23	4.05
WOLVERHAMPTON (Staffordshire), Wrottesley, E. Simpson, Esq.	500	July	29.660	1.632	84.3	40.4	43.9	70.8	49.9	20.9	58.5	50.5	.368	4.2	1.4	76	529	—	—	—	9	5	6	11	—	6.0	6	0.52
		Aug.	29.480	0.756	73.0	37.0	36.0	63.9	46.4	17.5	53.4	46.6	.317	3.6	1.0	78	532	—	—	—	9	11	3	8	—	8.0	84	2.56
		Sept.	29.352	0.798	70.2	28.6	41.6	60.4	43.7	16.7	51.3	45.6	.306	3.5	0.8	81	532	—	—	—	4	5	11	10	—	6.1	18	3.80
LEICESTER (Town Museum), J. C. Smith, Esq.	238	July	29.892	0.644	90.8	41.6	49.2	74.4	52.5	21.9	62.7	51.4	.380	4.1	2.2	67	529	125.4	45.4	0.5	8	6	9	8	—	5.8	3	0.13
		Aug.	29.760	0.776	76.0	40.5	35.5	66.0	50.1	15.9	56.6	48.5	.342	3.8	1.3	74	532	107.8	41.5	0.7	11	6	5	9	—	7.0	14	2.87
		Sept.	29.573	0.885	76.0	31.6	44.4	64.5	46.4	18.1	54.4	52.2	.392	4.5	0.4	92	533	108.2	35.4	0.8	7	3	9	11	—	4.6	18	3.23
NOTTINGHAM (Notts), M. O. Tarbotton, Esq., C.E., F.G.S., F. R. Met. Soc.	128	July	30.016	0.688	89.1	42.9	46.2	71.5	52.5	19.0	60.4	52.8	.398	4.5	1.4	76	534	135.1	46.8	0.1	3	6	12	10	0.1	5.8	6	0.34
		Aug.	29.883	0.797	74.4	39.4	35.0	64.1	50.6	13.5	56.1	46.2	.314	3.5	1.5	69	535	109.8	44.5	0.2	5	10	10	6	0.9	7.3	15	2.23
		Sept.	29.692	0.809	73.9	31.6	42.3	62.2	46.6	15.6	53.5	46.1	.311	3.5	1.1	77	536	111.3	41.7	0.2	4	4	12	10	0.6	5.5	23	3.85
HOLKHAM (Norfolk), John Davidson, Esq., Assistant to the Earl of Leicester.	39	April	29.706	1.050	69.9	22.5	47.4	53.5	36.2	17.3	45.0	37.0	.220	2.6	0.8	74	546	106.4	30.4	1.2	11	5	11	3	—	5.7	13	0.99
		May	29.692	0.874	63.0	26.0	47.0	55.4	36.7	18.7	45.5	40.1	.243	2.9	0.6	82	544	117.6	31.9	1.3	11	2	11	7	—	5.9	17	1.63
		June	29.966	0.968	81.1	31.6	49.5	65.4	46.0	19.4	55.8	48.8	.347	3.9	1.1	78	538	128.0	43.7	1.0	11	5	10	4	—	5.5	—	—
		July																										
		Aug.																										
		Sept.																										
BURSLEM, J. E. Worth, Esq., C.E., F. R. Met. Soc.	556	July	29.563	0.696	82.0	44.1	37.9	68.6	51.9	16.7	58.8	51.8	.385	4.3	1.3	77	537	—	48.1	0.8	7	6	8	10	—	5.7	12	1.11
		Aug.	29.369	0.814	71.5	39.7	31.8	61.6	48.6	13.0	51.7	47.8	.332	3.7	0.9	80	529	—	44.0	1.0	6	12	4	9	—	6.7	16	1.67
		Sept.	29.224	0.918	69.1	32.6	36.5	59.1	45.6	13.5	51.6	45.9	.309	3.5	0.8	81	529	—	40.9	1.0	5	3	12	10	—	6.0	22	3.82
LLANDUDNO (Carnarvonshire), James Nicol, Esq., M.D.	100	July	30.041	0.740	75.5	45.0	30.5	66.2	53.9	12.3	59.2	52.0	.389	4.4	1.4	77	535	—	—	0.8	5	5	4	17	—	6.1	7	1.57
		Aug.	29.857	0.950	69.0	44.0	25.0	62.2	51.5	10.7	56.3	48.8	.316	3.9	1.1	74	535	—	—	1.1	5	11	6	9	—	6.6	10	0.91
		Sept.	29.689	1.050	66.8	40.2	26.6	60.7	49.6	11.1	54.9	47.3	.324	3.7	1.2	75	534	—	—	1.3	2	2	6	20	—	6.3	18	2.87
LIVERPOOL, The Observatory, John Hartnup, Esq., F.R.A.S.	197	July	29.917	0.553	74.8	47.8	27.0	66.5	54.3	12.2	59.1	50.2	.363	4.1	1.5	72	534	—	—	1.0	1	5	6	19	—	4.3	9	2.29
		Aug.	29.758	0.908	69.2	43.7	25.5	63.0	51.2	11.8	55.4	47.2	.324	3.7	1.3	74	535	—	—	1.3	4	14	4	9	—	5.8	12	1.94
		Sept.	29.593	1.038	65.3	35.6	29.7	60.0	49.1	10.9	53.6	46.3	.313	3.4	1.2	76	534	—	—	1.6	2	5	10	13	—	5.3	22	4.00
BOLTON, Sharples (Lancashire), Rev. T. Mackereth, F.R.A.S., F. R. Met. Soc.	500	July	29.604	0.740	79.7	40.1	39.6	66.8	49.5	17.3	56.8	50.2	.361	4.1	1.1	79	530	80.3	48.4	0.5	6	6	8	11	2.4	6.2	8	2.46
		Aug.	29.437	0.870	73.1	38.4	34.7	62.1	47.3	14.8	53.2	46.3	.315	3.5	1.0	77	531	74.6	48.2	0.5	6	11	6	8	3.1	6.9	18	2.13
		Sept.	29.274	0.948	68.1	31.9	36.2	59.0	44.1	14.9	50.9	45.6	.306	3.5	0.6	83	531	70.4	41.3	0.8	6	3	9	13	2.9	6.9	24	6.96
HALIFAX, Bermerside Observatory (Yorkshire), E. Crossley, Esq., F.R.A.S.	530	July	29.696	0.718	87.0	40.0	47.0	69.2	49.1	20.1	58.2	49.1	.350	3.9	1.6	72	530	103.6	46.9	0.7	8	7	8	13	—	5.8	7	1.19
		Aug.	29.434	0.890	74.0	38.0	36.0	62.7	46.2	16.5	52.6	44.9	.321	3.7	0.9	81	532	95.6	48.1	0.9	6	12	5	8	—	6.7	10	1.01
		Sept.	29.287	1.010	70.7	33.0	37.7	60.6	43.7	16.9	51.3	45.6	.309	3.5	0.8	82	532	96.6	38.4	1.4	3	3	11	13	—	6.0	26	3.58

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1885. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour in a cubic foot of Air. Mean.	Vapour in a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Sat. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
HULL (Yorkshire), The People's Park, Mr. E. Peak.	6	July	30·160	0·782	84·0	44·0	40·0	68·9	51·4	17·5	59·3	52·0	·388	4·3	1·4	75	537	98·0	49·5	1·2	7	3	9	12	—	5·5	6	0·56
		Aug.	29·974	0·850	74·0	38·0	36·0	62·5	47·9	14·6	54·7	47·1	·323	3·6	1·2	75	539	88·0	46·5	1·4	14	2	5	10	—	6·9	9	2·01
		Sept.	29·809	0·920	71·0	32·0	39·0	61·2	44·6	16·6	52·2	44·7	·295	3·4	1·1	76	530	85·8	42·1	1·6	5	2	8	15	—	4·1	17	2·46
STONYHURST (Lancashire), Rev. S. J. Perry, F.R.S., F.R. Met. Soc., F.R.A.S.	363	July	29·772	0·766	80·8	38·9	41·9	68·9	49·3	19·6	57·5	52·2	·391	4·3	0·9	83	532	125·5	47·4	—	8	4	3	21	—	6·8	10	2·40
		Aug.	29·582	0·931	74·1	36·9	37·2	64·0	46·1	17·9	54·1	47·6	·329	3·7	1·1	78	533	121·9	43·7	—	10	9	3	9	—	8·1	10	2·60
		Sept.	29·426	0·977	68·2	29·8	38·4	60·8	43·4	17·4	51·4	45·5	·307	3·5	0·8	81	533	118·5	40·5	—	5	2	6	17	—	6·9	22	5·25
BRADFORD (Yorkshire), J. McLandsborough, Esq., C.E., F.G.S.	366	July	29·764	0·681	82·2	44·8	37·4	69·0	52·8	16·2	59·2	49·2	·350	4·0	1·7	70	531	92·1	—	0·3	5	8	7	11	—	5·6	7	0·77
		Aug.	29·558	0·874	71·0	42·0	29·0	62·2	49·6	12·6	54·5	46·0	·310	3·5	1·3	73	532	81·7	—	0·8	14	7	5	6	—	7·2	9	0·78
		Sept.	29·406	1·051	70·0	35·0	35·0	60·0	45·6	13·4	52·5	45·0	·300	3·4	1·0	77	532	81·1	—	0·9	6	4	7	13	—	6·3	22	2·89
LEEDS (Yorkshire), The Philosophical Hall, Henry Crowther, Esq.	137	July	30·000	0·712	84·0	46·0	38·0	70·4	53·4	17·0	60·7	51·0	·374	4·1	1·4	69	533	—	—	1·4	4	5	6	16	—	5·1	6	0·89
		Aug.	29·822	0·892	77·0	42·0	35·0	64·6	50·2	14·4	55·5	47·8	·334	3·8	1·2	75	546	—	—	1·3	11	9	3	8	—	7·3	10	0·85
		Sept.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
LANCASTER (Southfields), William Roper, Esq., F.R. Met. Soc.	114	July	30·027	0·780	80·0	46·0	34·0	66·0	52·6	13·4	58·2	51·2	·377	4·2	1·3	78	536	—	—	—	5	8	9	14	—	—	8	2·07
		Aug.	29·831	0·822	73·0	39·5	33·5	64·1	49·0	15·1	55·4	49·5	·355	4·0	1·0	81	536	—	—	—	5	11	6	9	—	—	12	3·08
		Sept.	29·677	0·874	68·0	33·0	33·0	59·7	47·0	12·7	52·6	48·0	·336	3·8	0·7	84	536	—	—	—	4	3	10	13	—	—	20	4·36
CARLISLE, Spital (Cumberland), Isaac Cartmel, Esq., F. R. Met. Soc.	114	July	29·994	0·844	82·2	40·3	41·9	70·7	48·9	21·8	58·4	51·5	·382	4·3	1·3	78	535	105·8	44·2	0·7	4	5	5	17	2·6	8·0	10	1·96
		Aug.	29·832	1·044	73·8	31·8	42·0	65·7	46·6	19·1	54·6	49·1	·348	3·9	0·9	81	537	96·0	41·7	0·6	5	7	4	15	2·5	7·6	8	3·18
		Sept.	29·630	1·058	70·3	26·5	43·8	61·9	43·7	18·2	52·2	42·1	·268	3·1	1·3	69	536	90·8	37·0	0·9	2	12	3	13	2·6	6·6	16	3·62

Second Rain-gauges are placed—

	March.	April.	May.	June and July.	August.	September.	Total in Quarter.
At Eastbourne at the height of 160 feet *above the sea;* the amount collected was	2·65 ins.	1·17 ins.	2·89 ins.	0·71 ins.	— ins.	— ins.	— ins.
" Beachey Head " 515 " " "	2·01 "	0·55 "	1·72 "	1·09 "	— "	— "	— "
" " " " 495 " " "	2·78 "	1·09 "	2·10 "	1·16 "	— "	— "	— "
" Oxford " 22 " *ground* "	— "	— "	— "	June. — ins. July. 0·11 ins.	1·57 ins.	4·13 "	5·81 "
" Cardington " 21 " " "	— "	— "	— "	— " — "	2·48 "	3·51 "	— "
" Nottingham " 48 " " "	— "	— "	— "	— " 0·27 "	2·05 "	3·57 "	5·89 "
" Holkham " 4 " " "	— "	1·18 "	1·73 "	2·08 " — "	— "	— "	— "

Fog prevailed in July, on the 3rd at Stonyhurst; on the 10th at Lowestoft; on the 14th at Stonyhurst; on the 15th at Marlborough; on the 19th and 20th at Guernsey; on the 21st at Guernsey, Torquay; on the 22nd at Torquay, Marlborough; on the 23rd at Marlborough; on the 24th at Marlborough, Wolverhampton; on the 25th at Stonyhurst; on the 26th at Hull; on the 27th at Lowestoft, Wolverhampton.

In August, on the 4th at Leicester, Liverpool; on the 5th at Marlborough, Hull; on the 6th at Marlborough, Wolverhampton; on the 7th at Leicester; on the 15th at Leicester, Hull; on the 16th at Hull; on the 18th at Leicester, Stonyhurst; on the 19th and 20th at Leicester; on the 23rd at Liverpool; on the 24th at Torquay, Southbourne, Leicester, Liverpool; on the 25th at Blackheath, Barnet, Oxford, Cambridge, Wolverhampton, Leicester, Liverpool, Stonyhurst; on the 26th at Totnes, Torquay, Cambridge, Leicester; on the 27th at Totnes, Torquay, Leicester; on the 28th at Totnes, Liverpool.

In September, on the 3rd at Barnet; on the 17th at Wolverhampton; on the 8th at Barnet, Leicester, Stonyhurst; on the 9th at Leicester; on the 13th at Torquay; on the 14th at Torquay, Barnet; on the 17th at Leicester, Bolton; on the 18th at Barnet, Cambridge, Leicester, Bradford; on the 20th and 21st at Guernsey; on the 22nd at Blackheath; on the 23rd at Guernsey; on the 26th at Leicester; on the 27th at Lowestoft, Somerleyton; on the 28th and 29th at Blackheath.

NAMES OF STATIONS.	Mean Pressure of dry Air reduced to the level of the Sea.	Highest Reading of the Thermometer.	Lowest Reading of the Thermometer.	Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Wind. Mean Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	[illegible]	Rain. Number of Days on which it fell.	Rain. Amount collected.
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
Guernsey	29·619	79·6	44·8	34·8	65·1	53·1	25·7	12·0	58·1	53·2	·406	4·6	0·9	83	535	114·5	46·8	1·0	7	6	6	11	2·5	5·1	42	6·55
Truro	29·516	89·0	30·0	59·0	68·5	49·4	43·0	19·1	56·9	51·9	·388	4·4	0·9	83	534	—	—	2·2	7	5	7	11	—	5·8	43	10·14
Plymouth	29·605	81·2	34·5	46·7	66·5	51·6	33·0	14·9	58·4	52·8	·401	4·5	1·0	81	538	—	—	1·2	7	8	6	10	—	5·7	41	6·92
Totnes	29·685	88·2	28·3	59·9	68·8	47·3	44·6	21·0	57·7	50·3	·365	4·0	1·3	76	535	—	—	1·9	8	7	5	10	—	5·5	40	7·33
Torquay	29·671	85·6	36·0	49·6	66·1	51·8	36·1	14·4	58·2	50·0	·361	4·0	1·4	74	531	121·7	44·9	1·4	7	7	5	11	4·6	5·6	38	6·27
Ventnor	29·619	83·0	36·6	46·4	66·5	54·3	32·2	12·2	58·8	51·8	·378	4·2	1·4	76	534	—	—	1·0	6	8	7	10	—	5·7	31	4·39
Osborne	29·613	94·5	36·0	58·5	70·2	51·3	40·6	18·9	58·9	53·7	·413	4·6	1·0	83	532	116·0	50·1	0·2	6	4	11	9	—	5·2	37	5·82
Southbourne	29·635	82·9	32·5	50·4	66·7	50·4	36·0	16·3	57·8	50·3	·366	4·1	1·3	86	534	—	—	1·4	9	7	6	9	—	4·5	33	4·20
Brighton	29·674	84·4	34·0	50·4	66·9	52·0	33·4	14·9	58·8	51·0	·369	4·2	1·4	75	532	104·2	45·6	1·3	7	5	8	11	—	5·0	33	5·32
Salisbury	29·624	94·0	27·0	67·0	71·9	45·1	49·0	26·8	57·9	51·7	·387	4·0	1·1	80	532	113·0	43·3	1·1	10	5	10	6	—	5·7	45	5·43
Barnstaple	29·685	90·0	38·0	52·0	69·4	55·9	37·3	13·5	60·8	52·6	·398	4·5	1·4	76	532	—	—	1·3	6	6	9	10	—	2·6	36	8·87
Rodmersham	—	81·5	34·0	47·5	65·9	49·0	40·3	16·9	57·0	50·7	·371	4·2	1·1	80	—	109·9	42·2	1·9	9	6	8	7	2·3	5·8	28	5·81
Marlborough	29·655	87·1	30·0	57·1	67·2	48·1	43·0	19·1	56·7	49·4	·355	3·9	1·1	86	529	121·6	42·7	0·7	7	8	6	10	—	5·6	41	5·83
Blackheath	29·635	87·1	35·5	51·6	69·3	51·0	37·7	18·3	58·9	50·6	·370	4·1	1·4	74	532	112·3	—	1·0	6	8	6	11	—	5·2	31	5·51
Royal Observatory	29·627	90·2	30·6	59·6	70·5	49·8	43·8	20·7	59·1	51·3	·379	4·2	1·4	76	534	126·6	42·1	—	—	—	—	—	3·1	6·4	36	5·55
Camden Square	29·662	90·4	33·7	56·7	70·2	51·4	39·0	18·8	58·4	49·2	·352	3·9	1·6	72	534	106·7	46·2	—	9	8	6	8	—	5·7	37	5·67
Barnet	29·688	88·0	27·7	60·3	69·5	46·5	47·1	23·0	57·1	49·6	·355	4·0	1·3	76	534	122·5	43·2	0·7	9	8	8	11	—	5·6	29	5·28
Oxford	29·644	85·8	32·2	53·6	67·6	50·2	49·3	17·3	56·7	50·4	·367	4·1	1·5	75	532	115·8	43·9	2·5	8	3	8	9	4·1	5·7	30	6·07
Royston	29·681	87·6	32·5	55·1	68·7	49·4	41·5	19·3	57·0	50·5	·369	4·1	1·1	77	533	—	—	—	9	6	7	9	—	5·5	32	5·42
Cardington	—	91·2	30·5	60·7	—	—	45·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6·41
Cambridge	29·621	90·0	30·2	59·8	70·5	48·3	45·0	22·2	58·0	51·0	·375	4·2	1·2	78	535	130·6	45·8	2·5	5	8	5	13	—	5·9	38	4·73
Rugby	29·611	90·8	26·8	64·0	68·6	46·8	46·3	21·8	56·7	50·0	·362	4·1	1·1	81	531	—	—	0·6	8	6	9	8	—	6·2	32	5·54
Lowestoft	29·646	76·7	32·7	44·0	64·8	50·9	38·2	13·9	57·2	49·6	·356	4·0	1·3	86	535	112·6	47·1	1·9	6	8	7	9	—	6·3	42	6·36
Somerleyton	29·627	79·8	33·0	46·8	64·9	49·9	37·6	15·0	56·3	50·2	·364	4·1	1·0	79	533	—	—	1·0	8	7	7	9	6·3	5·6	43	6·30
Wolverhampton	29·701	84·3	28·6	55·7	65·0	46·6	40·5	18·4	54·4	47·6	·331	3·8	1·1	78	531	—	—	—	7	7	7	10	—	6·7	38	6·88
Leicester	29·611	90·8	31·6	59·2	68·3	49·7	43·0	18·6	57·9	50·7	·371	4·1	1·3	78	531	113·8	40·8	0·7	9	5	8	9	—	5·8	35	6·22
Nottingham	29·687	89·1	31·6	57·5	65·9	49·9	41·5	16·0	56·7	48·4	·341	3·8	1·3	74	535	118·7	44·2	0·2	4	7	11	9	0·5	6·0	46	6·42
Burslem	29·651	82·0	32·6	49·4	63·1	48·7	35·4	14·4	54·7	48·5	·342	3·8	1·0	79	528	—	44·3	0·9	6	7	8	10	—	6·1	50	6·60
Llandudno	29·616	75·5	40·2	35·3	63·0	51·7	27·4	11·4	56·8	49·4	·353	4·0	1·2	75	535	—	—	1·1	4	6	5	15	—	6·3	35	5·35
Liverpool	29·640	74·8	38·6	36·2	63·2	51·5	27·4	11·6	56·0	47·9	·333	3·7	1·3	74	534	—	—	1·3	2	8	7	14	—	5·1	43	8·23
Bolton	29·655	79·7	31·9	47·8	62·6	47·0	36·8	15·7	53·6	47·4	·328	3·7	0·9	80	531	55·1	46·0	0·6	6	7	8	10	2·8	6·7	50	11·52
Halifax	29·694	87·0	33·0	54·0	64·2	46·3	40·2	17·0	54·0	47·3	·327	3·7	1·1	78	531	99·3	42·8	1·0	5	7	8	11	—	6·2	43	5·78
Hull	29·659	84·0	32·0	52·0	64·2	48·0	38·3	16·2	55·4	47·9	·335	3·8	1·2	75	538	90·4	46·0	1·4	9	2	7	12	—	5·5	32	5·03
Stonyhurst	29·639	90·8	39·8	51·0	64·6	46·3	39·2	18·3	54·3	48·8	·342	3·8	0·0	81	533	122·3	43·9	—	6	5	4	16	—	7·3	42	10·23
Bradford	29·651	82·2	35·0	47·2	63·7	49·7	33·8	14·1	55·4	46·7	·320	3·6	1·3	73	532	85·0	—	0·7	8	6	8	10	—	6·4	38	4·41
Lancaster	29·613	80·0	33·0	47·0	63·3	49·5	33·5	13·7	55·4	49·6	·350	4·0	1·0	81	536	—	—	—	5	6	8	12	—	—	40	9·51
Carlisle	29·606	82·2	26·5	55·7	66·1	46·4	42·6	19·7	55·1	47·6	·333	3·8	1·2	76	536	97·5	41·0	0·7	4	8	4	15	2·6	7·4	34	8·78

The highest temperatures of the air were at Osborne, 94°·5; at Salisbury, 94°·0; at Cardington, 91°·2.
The lowest temperatures of the air were at Carlisle, 26°·5; at Rugby, 26°·8; at Salisbury, 27°·0.
The greatest ranges of temperature were at Salisbury, 26°·8; at Barnet, 23°·0; at Cambridge, 22°·2.
The least ranges of temperature were at Llandudno, 11°·4; at Liverpool, 11°·6; at Guernsey, 12°·0.
The greatest number of days of rain were at Burslem and Bolton, 50; at Nottingham, 46.
The least number of days of rain were at Rodmersham, 28; at Barnet, 29; at Oxford, 30.
The greatest falls of rain were at Bolton, 11·52 inches; at Stonyhurst, 10·23 inches; at Truro, 10·14 inches.
The least falls of rain were at Southbourne, 4·20 inches; at Bradford, 4·41 inches; at Cambridge, 4·73 inches.

QUARTERLY METEOROLOGICAL TABLE for different PARALLELS of LATITUDE.

PARALLELS OF LATITUDE, &c.	Mean Pressure of dry Air reduced to the level of the sea.	Mean of all Highest Readings of the Thermometer.	Mean of all Lowest Readings of the Thermometer.	Mean Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Wind. Mean Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Mean Number of Days it fell.	Rain. Mean Amount collected.
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
Guernsey	29·649	79·6	44·8	34·8	65·1	53·1	25·7	12·0	58·1	53·2	·406	4·6	0·9	83	535	114·5	46·8	1·0	7	6	6	11	2·5	5·1	42	6·[illegible]
Between the latitudes 50° and 51°	29·621	86·3	33·4	52·9	67·6	50·9	37·9	16·7	58·1	51·5	·382	4·2	1·2	80	533	116·9	47·5	1·3	7	7	10	10	—	5·4	38	6·[illegible]
51° and 52°	29·649	88·0	32·3	55·7	68·9	49·7	43·3	19·2	58·2	50·5	·370	4·1	1·3	77	532	114·7	43·6	1·3	8	7	7	9	3·2	5·2	35	6·0[illegible]
52° and 53°	29·643	86·2	31·0	55·2	66·6	48·9	41·5	17·7	56·5	49·6	·357	4·0	1·1	79	532	118·9	44·0	1·1	7	7	8	9	3·4	6·0	29	6·[illegible]
53° and 54°	29·654	80·5	31·2	48·8	63·6	48·7	34·6	14·9	55·0	48·1	·337	3·8	1·1	77	534	96·4	44·7	1·0	6	6	7	12	—	6·2	40	8·3[illegible]
54° and 55°	29·608	82·2	26·5	55·7	66·1	46·4	42·6	19·7	55·1	47·6	·333	3·8	1·2	76	536	97·5	41·0	0·7	4	8	4	15	2·6	7·4	34	8·7[illegible]
Mean for the Quarter, 50° to 55°, Year 1882	29·480	78·3	36·1	42·2	66·3	49·9	32·9	16·4	56·9	50·9	·376	4·3	1·0	81	530	111·3	45·0	1·2	5	4	8	12	3·7	6·2	49	8·64
" 1883	29·481	77·6	39·5	38·1	64·5	50·7	32·8	15·8	57·4	51·6	·385	4·3	1·0	82	531	111·6	45·9	1·1	5	4	8	14	4·9	6·2	50	9·1[illegible]
" 1884	29·554	84·1	39·1	47·0	70·0	52·4	39·6	17·6	60·1	53·4	·411	4·2	1·0	79	526	113·4	47·5	1·0	4	7	8	14	4·1	5·7	43	7·8[illegible]
" 1885	29·635	84·7	31·5	53·2	66·6	48·9	40·0	17·7	56·6	49·5	·356	4·0	1·3	78	533	109·3	44·2	1·1	6	7	7	11	3·0	6·0	37	7·21

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